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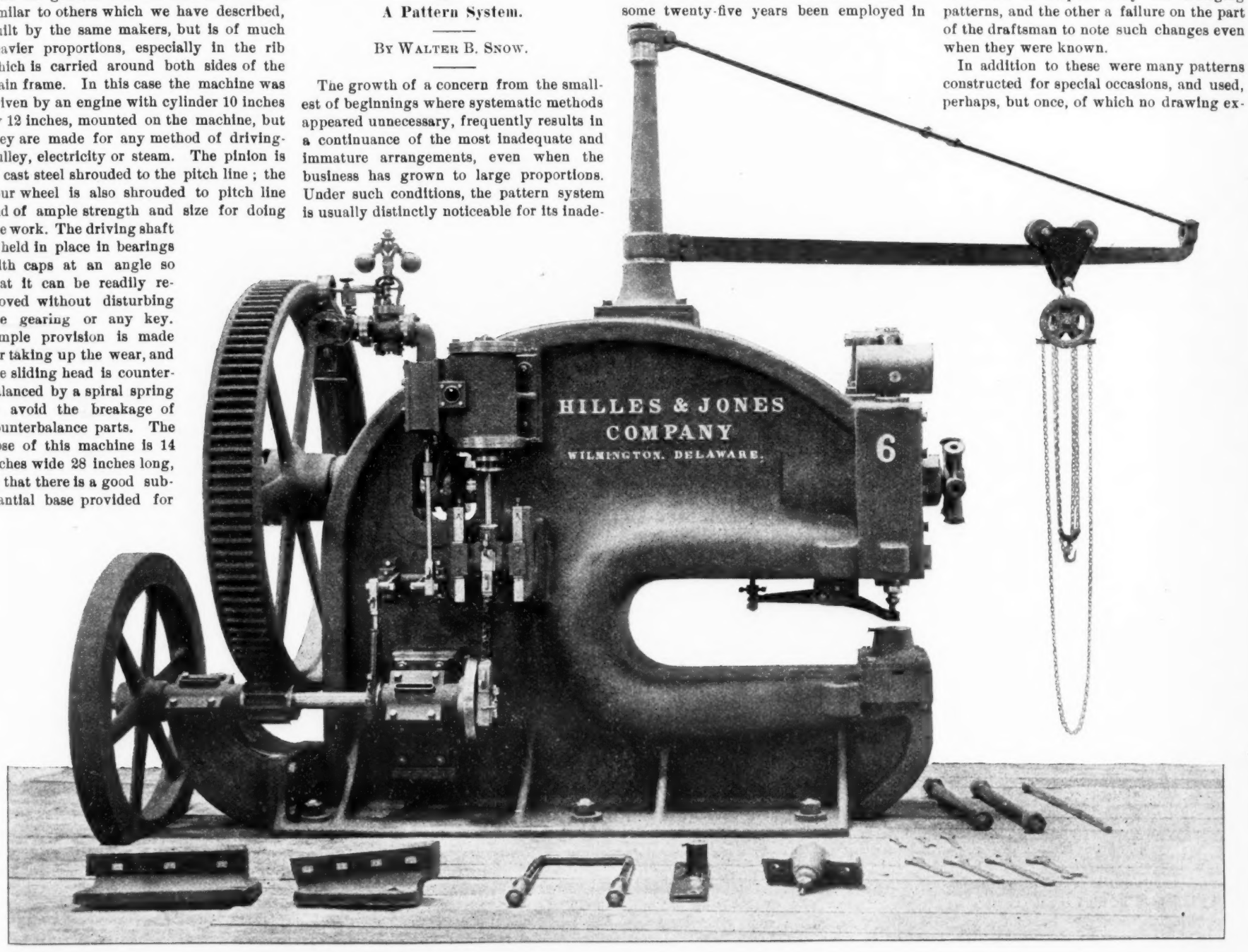
Heavy Punching and Shearing Machine.

We give on this page an illustration of a specially heavy design of single punch and shear, the machine from which the photograph was taken having a depth of throat of 54 inches and capacity for punching 6-inch diameter holes through 1-inch thickness of plate with a spiral punch and shearing 1¼ inches steel plate.

In its general features the machine is similar to others which we have described, built by the same makers, but is of much heavier proportions, especially in the rib which is carried around both sides of the main frame. In this case the machine was driven by an engine with cylinder 10 inches by 12 inches, mounted on the machine, but they are made for any method of driving-pulley, electricity or steam. The pinion is of cast steel shrouded to the pitch line; the spur wheel is also shrouded to pitch line and of ample strength and size for doing the work. The driving shaft is held in place in bearings with caps at an angle so that it can be readily removed without disturbing the gearing or any key. Ample provision is made for taking up the wear, and the sliding head is counterbalanced by a spiral spring to avoid the breakage of counterbalance parts. The nose of this machine is 14 inches wide 28 inches long, so that there is a good substantial base provided for the attachment of standard or special tools of any character. This length also allows trimming knives to be sufficiently long to take a good cut at each stroke. All of the punching and shearing tools are held in place by means of through bolts, so that these attachments can be changed any number of times without wearing the machine. In addition to the standard punching arrangement there is shown, in the foreground, a cast-steel die block which comes to the front of the nose and is used for punching flanged heads, angles or irregular work of this character. The self-contained crane with differential block carried in a trolley provides an easy and convenient method for changing the tools as well as handling plates, bars or other material which has to be worked. Total weight of this machine is about 58,000 pounds, the main frame alone weighing 40,000 pounds.

The machine is built by Hilles & Jones, Wilmington, Del.



HEAVY PUNCHING AND SHEARING MACHINE.

A Pattern System.

BY WALTER B. SNOW.

The growth of a concern from the smallest of beginnings where systematic methods appeared unnecessary, frequently results in a continuance of the most inadequate and immature arrangements, even when the business has grown to large proportions. Under such conditions, the pattern system is usually distinctly noticeable for its inadequacy, and there will likely be found no distinct and definite method of order, and, still less, any arrangement for numbering, designating or locating patterns. One man only—the general handy man of the foundry—will be found to be capable of finding a pattern when it is wanted, and with due respect to him it must be said that his memory, trained for years in this one duty, is usually a marvel to the uninitiated.

But the moment he is absent, the absolute dependence of the entire establishment upon one man is vividly realized. Countless hours are wasted in vain search, simply because of the lack of some comprehensive system controlled by the office and understood by all, whereby the name and location of any pattern may be immediately determined.

The description of the following system and the conditions under which it was evolved may, at least, serve to aid others in a solution of the problem.

The concern under consideration had for some twenty-five years been employed in the manufacture of blowers, heaters, steam engines, and sundry smaller articles. The blower patterns, in particular, had in many cases been originally constructed in general conformity to rough pattern drawings, but had subsequently been changed to a greater or less extent without corresponding correction of the drawings. In fact, the drawings, being only rough outlines, had seldom been preserved. The only designation of these patterns had been the size number, and the name stamped upon them, and then listed and upon which there was no designation whatever. All the patterns were located on shelves on the floors of three separate storage lofts, and the sole record of their exact location was the brain of the man whose duty it was to care for and handle them.

Under these existing conditions it was decided that something definite, absolute and final must be done toward straightening out the patterns and systematizing their making, designating and numbering. One frequently in such abbreviated form that none but one well acquainted with the business could interpret the inscriptions.

The heater and engine patterns had many of them been through the same experience, only to a lesser degree. They were similar in lack of other designation than the name; frequently there existed decided discrepancies between the pattern and the drawing. The cause of the latter condition was preeminently due to two causes: one, the absolute lack of responsibility for changing patterns, and the other a failure on the part of the draftsman to note such changes even when they were known.

In addition to these were many patterns constructed for special occasions, and used, perhaps, but once, of which no drawing ex-

part of the problem was simple, and the sole authority for ordering new patterns or changing old ones was accordingly at once vested in the chief draftsman.

The descriptive designation was also simple enough, as it covered merely the name and size number of the machine to which the part belonged. But the method of numbering and locating the patterns called for careful study. It was well appreciated that the simplest of all methods would be that whereby the pattern number also designated its location, or *vice versa*. But it was at once seen that from the character of the patterns such an arrangement would be practically impossible.

Any comprehensive system must make it possible for pattern numbers to be taken for patterns prior to their being made, and failure to make them at all should have no objectionable effect. In order that the number of a pattern should indicate its location in the storage house that space should be reserved for it, and this, with great diversity in the sizes of the patterns, would end in continued inconvenience and excessive waste of space.

Next was considered the advisability of grouping patterns for a given machine under some main symbol with designating prefix or suffix, and of placing all these patterns together upon the same shelf. But the diversity in sizes, the lack of space for future additional patterns for the same machine, and the fact that many patterns were used for several machines forbade the adoption of this method.

Finally, a decision was made upon the following system which has proved at once the simplest to understand and least complex in operation:

Each pattern is given a distinct number bearing no relation to its character or its destined location, but being merely one of a series running consecutively from one upwards. First of all, the old patterns, with certain exceptions found desirable because of existing circumstances, were taken in hand. Numbers were given and records made by a draftsman while the numbers were stamped by a patternmaker, the two working together in the storage lofts for several weeks. Most important in the work of the draftsman was the determination of the drawing corresponding to the pattern when such drawing existed, and to this end many patterns were very carefully measured in order to check all dimensions and leave no opportunity for a discrepancy between the two due to a change in the one without similar action regarding the other. Once determined, the number was plainly inked in upon the drawing, and there stands as a record whenever the drawing is examined.

For the further purpose of record two sets of books were provided, one for the drafting room covering columns headed pattern number, ordered, name of pattern, drawing number, order number, material, completed, labor, stock, total and remarks. The other book, designed for the foundry, covered only the pattern number, the name and the drawing number, together with the location, this latter to be filled in by the pattern keeper when the pattern was first given a definite place by him.

For the purposes of consecutive numbering and preliminary record a scratch book was provided to which any draftsman might go and obtain a number for the pattern he had drawn.

In order that the shrink as indicative of the kind of metal for which it was made, might be readily known by inspection of the pattern, a system of prefixes was adopted as follows—here shown in connection with a pattern number—cast-iron having no prefix whatever, and forging patterns being included in the list:

Cast-iron	1327
Brass	01327
Mitis iron and steel	001327
Copper	0001327
Forging patterns	x1327
Malleable iron	xx1327

In the giving of pattern numbers the principle was established that every pattern serving to form a casting separate from all others should have a distinct number, no matter if the casting, as in the case of a half crank-pin box or eccentric strap, was necessarily combined with another to make practically one piece, and further, it was determined that any change in a pattern that would prevent a casting from it being substituted for one made before the change, should compel the discarding of the old, and the substitution of a new number. By this means there could never be a mistake through ordering a casting from the changed pattern to replace one made before it was changed, for the old number would then have no existence, and the new would have nothing to indicate its connection therewith. Of course, under this ruling the number of the pattern drawing was changed, but being a tracing, record blue prints bearing the original number would be first taken, and such alterations then made in pattern and drawing number upon the tracing as might be desirable.

When a pattern was arranged by means of loose pieces to form a different casting, these pieces would be distinguished in number from the body pattern by suffix letters, as 5761A, and a casting from the combination pattern would be ordered thus, $\begin{cases} 5761 \\ 5761A. \end{cases}$ This method rendered it possible to make changes in some patterns without changing the original number, but this held only where a casting of the original form could also be produced from the same pattern by omitting the loose pieces.

The ordinary loose pieces of patterns and core boxes necessitated by the exigencies of molding, as well as the boxes themselves, were all numbered the same as the body pattern, and always kept with it.

thus a location would be noted as 27 B. Eventually, each pattern when finally located will have its location indicated by shellacing on a properly inscribed label.

Standard core prints and pulley hubs are arranged upon sliding shelves so as to be readily accessible, each shelf containing only those of a given size, and each pulley hub, for instance, always taking a given diameter core print. The pulley hubs all have pattern numbers distinct from the pulleys themselves, and are interchangeable thereon, so that any desired combination can be readily ordered with certainty of a proper casting as the result, the order reading, for instance,

$42''x8\frac{1}{2}''x2\frac{5}{16}''$ pulley $\begin{cases} \text{Pat. 2738 pulley.} \\ \text{Pat. 5627 hubs.} \end{cases}$

The orders for all patterns which, as previously stated, must emanate from the drafting room, are entered upon cards of the form shown in the accompanying reproduction. This has been found to cover all the items necessary and serves as the basis upon which costs are to be made up. These cards filled in as orders are issued from the drafting room with the drawings, remaining with them in the pattern shop until the pattern is completed, and are then returned after having the blank spaces properly filled. From these reports the total net cost of each pattern is figured and recorded in the drafting-room book previously described. There is thus collected data of great value, at hand for immediate use in the estimation of cost of future work.

In the column headed "Remarks" is recorded the weight of the casting from each pattern, it being the duty of the foundry foreman to turn this in upon the foundry orders as each is completed. Like

E 114 2M 12-22-92.

PATTERN COST CARD—ORDER NO. P1256

Dwg. No. 6-416 B. F. STURTEVANT CO. Jamaica Plain, Mass., Mar. 7 1894

NAME OF PATTERN.	Pattern No.	Material.	Amt. of Stock.	Kind of Stock.	Hours.
Valve stem guide for 10x12 hor. eng.	7632	Wood	1¼ ft.	Pine	15½

Wanted Rush 189 Completed Mar. 7 1894

Inspected J. P. Hamlin Foreman. No. 347 Name. O. E. Orton Workman.

A system of numbering pieces of machines when said pieces are not formed from castings has been combined with the pattern numbering and following along in the same consecutive list. Of course, such piece numbers bear no direct relation to the size or name of the machine, but the consecutive method of numbering has proved very simple in practice, the distinction between a pattern and piece being clearly indicated by the respective prefix *Pat.* or *Pc.*

As a part of the general system of shop orders introduced in this establishment, there exists for each complete machine a "production list," giving the name, drawing number, piece or pattern number, number of pieces and material required for a single machine. From this list is made up the foundry order specifying the name and number of pattern, with the number of castings required therefrom. Of course, the pattern keeper soon becomes familiar with the location of a large number of the patterns, his work being facilitated by keeping together those of the same general character. Thus in separate groups are steam engines, crossheads, crank-plates, pistons and the like. When memory fails, the book is at hand by which the location is at once determined.

The present arrangement of pattern shelves is inadequate and a separate pattern storage house will soon be provided; but it was adopted with this in view so that a mere extension of shelf room would not affect the present system of indicating the location. The shelves as now in use are made up in stacks like those of a library on a large scale. Each stack or tier has its number, while the individual shelves of the stack are distinguished by suffix letters, the record of cost this list is of great value.

Absolute inflexibility in rules frequently works a disadvantage in an otherwise serviceable system, and, therefore, some of the rules previously stated have these exceptions. In the case of rush orders a formal written order may follow the verbal, while pattern repairs of a general character are always made at the order of the foundry foreman and without formal order. But all labor and material required for such repairs is turned in upon a regular pattern cost card filled out by the patternmaker, the card thus forming a report rather than an order.

The patternmaker is generally a jack at-all-trades in wood, and to him are brought the odd jobs required in the way of repairs in the office and shop. It may be a belt shipper, a wood pulley, some compartments in an office drawer, a whiffletree for the team, or a hammer handle, but whatever it is he must attend to it at once. Such labor can in no sense be charged up to patterns, and is, therefore, ordered on an ordinary shop order, time and stock being reported upon time cards and stock memorandums, of the same character as those used by workmen in the other trades throughout the shop.

The total labor of patternmakers for the year as drawn off from the pay roll, less the labor expended in such shop jobbing as this, obviously gives the real labor account for patterns. If reports of repairs of patterns are also collected, the cost of operating this department becomes well itemized, for another process of subtraction gives the cost of new patterns, which may be checked against their cost as figured directly.

From the time the system was first introduced, it has been the understanding that no pattern, however simple, should be made without a properly recorded or filed drawing or sketch. By a system of filed sketches to scale, on 9″x12″ sheets, many of the simple and temporary patterns are furnished a record with very little expenditure of labor on the part of the draftsman. Of course, all important patterns are shown upon detail working drawings. As all drawings and sketches are card indexed, it is evident that the index of the drawing becomes also the index to the patterns. For the drawing being obtained, there is found thereon the record of the pattern number.

On the other hand, if the number of a given pattern is known, the drawing upon which it is shown may be learned by consulting the drafting-room record book of patterns. This interlocking of the system, together with its ready adaptability, has made it an assured success, and although it may present few features that are novel, it certainly possesses advantages that warrant its adoption in any establishment operating under similar conditions.

A New Electrical Locomotive.

There is an electric locomotive in course of construction in this city which promises to meet all the requirements for propelling railroad trains. It is an eight horse-power machine and it is unique.

The distinctive feature of the invention is the substitution of a piston and cylinder in place of the usual rotary motor for the application of power. The cylinder is much longer than for steam purposes, and has in its interior a series of magnets. The piston passes entirely through the cylinder, with crossheads at either end. On the piston within the cylinder is a series of armatures of peculiar construction. On the axle of the driving wheels are commutators whose function is to apply and cut off the electric current, just as the eccentrics control the steam of a steam engine. The principle of the machine is the admission of the current to the magnets in the cylinder, which are in advance of the piston rod, and by their action on the armatures the piston rod is moved forward. As the stroke is ended the current is cut off from the magnets first charged, and applied to those at the rear of the piston, giving it a reverse motion, thus maintaining a strong, regular motion There is absolutely no back pressure from the electric current, while in a rotary motor this is estimated at 20 per cent. of the force applied.

It is practicable to run the machine at 200 revolutions of the axle per minute, and with a driving wheel 8½ feet in diameter and the crank pin 3 feet from the center there would be a 6-foot stroke, under a full head of power. The machine is adapted to receive the electric current either by a trolley wire, a third rail in the track or from a storage battery.—*Boston Transcript.*

"What's the fare from here to Detroit now?" he asked of the ticket agent of Court street depot, says the Minneapolis *Journal*.

"Same as always," was the reply.

"The same as before the panic?"

"Yes, sir."

"But I don't see into it. I've had my wages cut down on account of hard times."

"Can't help that, sir."

"And the fare to Detroit ought to be cut down"

"But it hasn't been."

"Hasn't, eh? Then there must be a good reason for it."

"Yes, there is. The oil of the engines costs just as much as ever it did."

"Oh-h-h! I see! Nothing off on oil, eh?"

"Nothing off."

"Wall, that makes it all right. I thought there must be some reasonable explanation for keeping the fare up. If oil goes down the fare goes down. If oil stays up the fare stays up. I see. Gimme a full-fledged ticket to Detroit, and you can say to the railroad folks that I'm perfectly satisfied with your explanation!"

Hydraulic Boiler Shell Plate Bender—Tweddell's System.

It may be said in a general way that the claims made for this machine are rapidity of operation and more satisfactory work than that obtained by ordinary methods. By its use the plates are finished to the extreme end, any further manipulation, after bending, for that purpose being avoided, a true curve, for riveting, being presented.

The machine consists of three vertical girders, the two outside ones being connected by top and bottom girders. The central one is moved in a perfectly parallel plane by a hydraulic ram working a cylinder attached to the left-hand girder. On this girder are two inclined planes, and working on these are two sets of two rollers connected together by tie rods. The tie rods being pushed up by the hydraulic rams, the result is that the roller acting on the straight facings of the moving girder push this forward for the desired distance. The outer face of this girder is concave, the face of the opposite girder being convex. A plate placed between these can be bent to any desired radius. It is not necessary that the girders be of the exact radius, and as made they suit all diameters of boiler shells.

When desired the machine is arranged so that a complete circle can be bent and lifted over the top of the right hand girder. The practical results are: 1st. That the plate can be bent to a true curve to the very end. 2d. That narrow curved plates or cover plates can be bent as easily as complete shell plates. 3d. That it is impossible to overfeed, and thereby break the machine.

As regards speed of working, a large plate, say, 1⅝ inches thick, 13 feet wide, can be bent *with final curve* at from 2 to 2½ feet per minute. There is no passing through the dies a second time. The mode of working is extremely simple. The plate having been placed on end on round steel bars about ½ inch diameter, resting on cast floor plates, in which are a number of square holes, something like those used for turning ships' frames, and also resting on the rollers on the bedplate of machine, the plate is easily fed forward by one man with an iron bar, of which one end enters one of the holes on the floor plate. Some tack holes having been drilled in the edge of the plate, the iron bar catches a bar put into one of these, and the plate is then fed forward about 3 inches for each stroke of bender. A second man works the valve, and with a gauge or template sees that the radius is correct. The whole apparatus is worked by three men and a boy.

Another advantage is the small amount of floor space occupied by the machine, only 15 feet by 5 feet 6 inches, being required for a machine capable of dealing with cold steel plates 1⅝ inches thick by 13 feet 1½ inches wide. The machine can also be placed in any part of the shop, and is not dependent upon position of shafting nor does it require a steam engine attached.

These machines are made to suit the Tweddell standard pressure of 1,500 pounds per square inch, but, of course, can be made to work at any other pressure if desired.

The cost for foundation is nominal, and the total cost of installation low.

These machines are made by Messrs. Fielding & Platt, of Gloucester, England, and are patented in the United States.

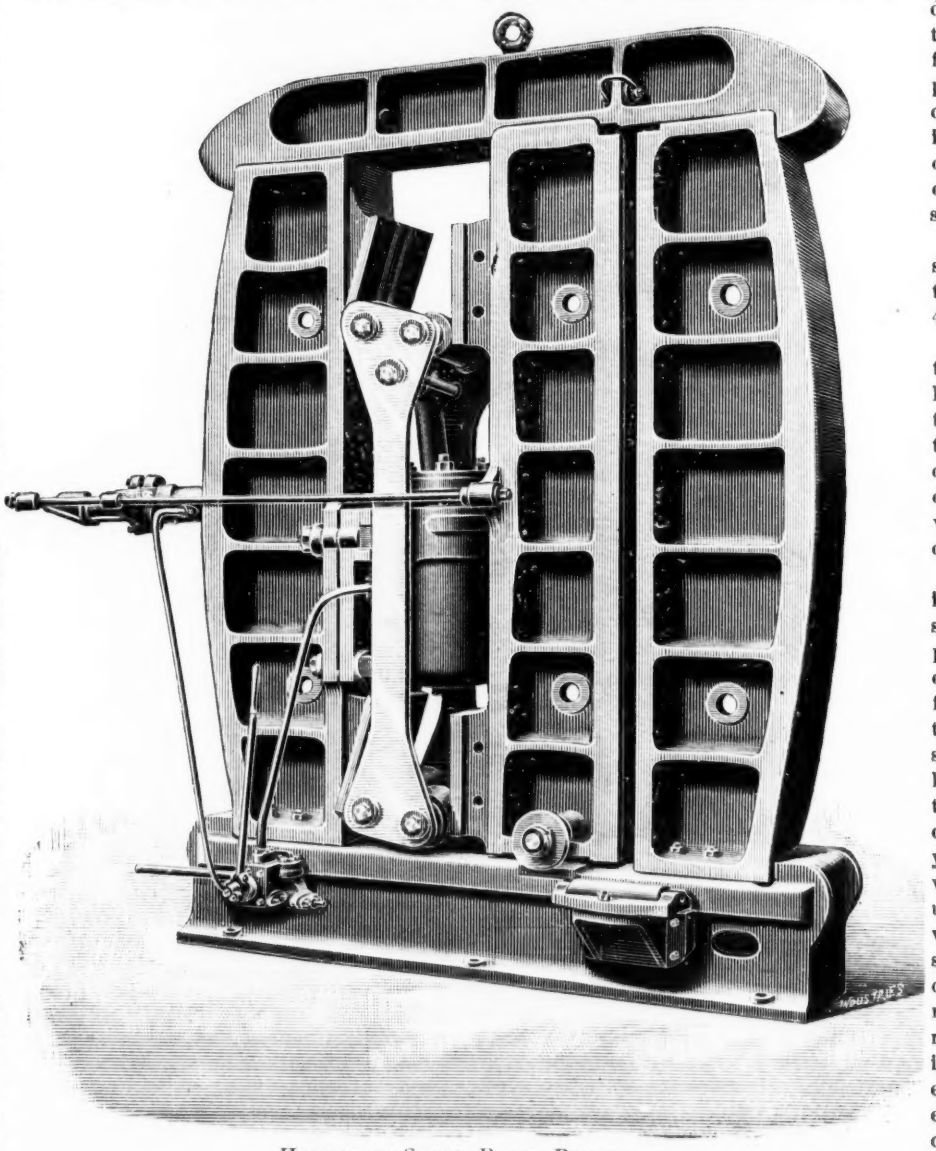
We are indebted to Mr. Ralph H. Tweddell, M. Inst. C. E., of 14 Delahay street, London, England, for the data in relation to this machine, who may be addressed in relation to it.

Some years ago we published the experience of an engineer with a safety valve that failed to "blow" after the pressure had become dangerously high. The trouble was with a loose bush, which followed the valve up as the pressure raised it. Since that time we have read of several similar cases, all of which go to show that the bush should be screwed to place or otherwise made fast.

Cupola Practice.

BY HERBERT M. RAMP.

Countless articles have been written, and years of patient study devoted to cupola practice. But the majority of writers on the subject confine themselves to what can be done with excellent facilities and ideal conditions, with patent cupolas and paper theories. This is well in its way, but it does not assist the thousands of foundrymen who have to use old-style methods and old-style cupolas. We need a closer investigation and study of the old way to benefit those who are compelled to use it. The foundry foreman needs a more practical and simple treatment of the subject than is usually given. He has not time to study chemistry, metallurgy and theories. His other necessary duties consume his time too largely for that. Plain simple facts are what he needs; how to get good results with poor appliances, and how to improve the same at cheap figures. Any one with good judgment can run a good cupola, when he has full instructions to follow, and the thinking has all been done for him. On the foreman devolves the responsibility of his cupola, and how many foundry foremen ever studied the same before they reached that position? Good mechanics and managers have failed as foremen through their inability to handle the cupola.



HYDRAULIC SHELL PLATE BENDER.

One trouble is men do not study principles enough; they follow rules laid down by others, and never master the subject themselves. Rules are for apprentices and blockheads.

A number of patent cupolas have been put on our market for which a great deal is claimed, and they have often justified these claims regarding their merits, and fulfilled their guarantee, but did so more through careful intelligent work, than their patent features. If the same attention and care were given an old-style cupola that is given a patent one, the result would astonish some. When a man buys a patent cupola he has it erected and run according to the instructions of men who have mastered the principles of the art, but when he builds an old-style, it is put up with very little thought—built like one his father erected, and run in a desultory manner. The results are poor, the system condemned, and a good price paid afterwards for a patent one and instructions. Or, it remains a source of trouble and expense. This is a fact that has often come under my observation. To show what can be done with what I term an old style cupola, I will refer to the one I am now using, describe it and my plan of operation, and show the results.

It is a plain cylindrical cupola, with a wind-box around, and six tuyeres entering it, 4x5 inches square. It is 40 inches clear of the brick in diameter. The charging door is 12 feet from the bottom, and we use a No. 10 Buffalo blower. At present we are running heats of 15 tons, using fuel at the rate of 1 to 11.27. On 20 ton heats we can melt 1 to 12, and 25 ton, 1 to 13. The larger the heat the cheaper it is melted, and it is so in any cupola. Ten ton heats show a ratio of about 1 to 10. The fuel used is the best Connellsville coke, and iron melted is pig and heavy railroad scrap. As regards time, we melt from 7 to 8 tons per hour, and often 9, doing it easily, and making first class iron. These are figures I can substantiate, if necessary.

Turning to patent cupolas, where do they make their boasted 25 to 50 per cent. over this? In the instance of one of those cupolas in the catalogue the company issues, a 42 inch is rated at from 5 to 7 tons per hour, and says a ratio of 1 to 12 5 has been reached on long heats. Compare this with the record of the 40 inch I have just written of, and see if there is a marked improvement. It shows for itself that the improvement lies more in the instructions and knowledge these parties have gained of melting iron than in the patented features.

Thos. D. West, in his paper published in your issue of November 2, 1893, says: "To-day it is a point open for dispute, if a better understanding of the science of running a cupola has not as much to do with its economical operation as any improvements in the construction of cupolas." And I believe it to be correct, but differ from him in respect to the impossibility of advance in the matter of economy, which he speaks of later on in his paper. I do not believe we have developed the common cupola to its utmost, as continued study and experience has taught me. One to 7 and 1 to 8 is poor melting for an old-style cupola when the remedy is so easily effected, when it can be made 1 to 11 with little expense. I have run a 30-inch cupola for three hours, and melted at the rate of 4½ tons per hour, and dropped the cupola clean, and made good iron all the way through, using fuel at the rate of 1 to 10, with nothing but a common cupola.

Proper wind area in the tuyeres and pipes connecting to blower, and a careful study of the material you use for flux, are the most important points to study in cupola practice, and the ones that are easily experimented on.

It is needless for me say that the blower should be placed as near the cupola as possible, and with as few bends in the pipe as you can make, for that is known and conceded by all; also that the main pipe should be from three to four inches larger in diameter than the mouth of the fan. But the question of tuyere area and tuyere formation and location is one much disputed. Theories without number, and countless experiments have found their way into our foundries. A proper distribution of tuyeres, and the greatest concentration of volume possible will bring the best results.

By a proper distribution I mean tuyeres should be placed so as the blast can reach the bed at as many points as possible; in a 40 inch cupola, say, from 12 to 18.

By concentration of volume I mean the tuyere that will admit the blast with the least possible friction, and form it in a body that will carry the longest distance toward the center, and that is a round one. No one ever made the nozzle of a hose flat, oblong or square, if they wished to throw water a great distance, and air is the same, only more susceptible to friction.

The trouble with most common cupolas is the tuyeres are too large and far between; such a volume of air enters at three or four points, that it chills the slag, droppings and coke in front of them, debarring the blast from a free access to the fire, thereby retarding melting. At the same time the space between the tuyeres receives very little of its portion of the blast, and there the melting is slow also, even when the cupola is clean and free. The more points you have the blast enter, the more perfect will be combustion, and the greater the uniformity in the entire melting area, providing the size of tuyere is not reduced so small that the volume is not sufficient to carry it to the center. Three to five-inch round tuyeres will accomplish the desired result in cupolas ranging from 30 to 60 inches diameter, and a sufficient number to equal one ninth the melting area. Experience and study have taught me that this is correct. These are improvements that can be applied to any cupola at a trifling cost, and the results will always justify them.

Fluxing cupolas is where many fail, and many cupolas are "bunged up." Flux is often shoveled into a cupola indiscriminately; "use enough to make the slag run," is the rule often followed. No record is kept of amount used, no weights, nothing to work from. I find it as necessary to weigh my flux as to weigh my coke. Too much is just as detrimental as too little, and 10 pounds difference per charge either way will make a great difference in the time of heat, and the condition of cupola at the end. Flux should be used according to the amount of fuel used per charge, not the weight of iron charged. Coke makes the slag, and as you increase or decrease the amount of fuel used your flux should be used accordingly. Thirteen per cent. of flux in relation to fuel, when using limestone, gives me excellent results, but as limestone varies in different localities, a little experimenting is often necessary. As small an amount of flux as can be used, and cause the slag to flow freely, will clean the cupola best, and assist rapid melting.

Another error often made in fluxing is starting in the middle of the heat, instead of the beginning. When flux is used at all, it should start with the first charge. The habit of waiting until the seventh or eighth charge is wrong, because, up to that time you have been making just as much slag from your coke as will be made in any succeeding charges, and it has gathered in quite a quantity, and sometimes is very hard to move from the cupola; at the best some of it has chilled and become unmanageable, and is sure to be a detriment to rapid and economical melting. On the other hand, when flux is judiciously used from the first charge, it starts the scoria and slag to flowing off as fast as it forms, keeping the cupola clean and acting on the slag when in its most fluid state.

To run a cupola in the most economical way is to run it in the simplest manner. There is nothing difficult in running one of the most common type at the ratio of 1 to 10 the year around, running it for hours at a time. All it requires is a careful study and a close comparison of each day's work. I trust I shall hear from others on the subject as regards old-style cupolas, and show what can be done with common facilities. I do not desire to attack improvement or progress in any form, but would like to see a more careful consideration given to the common cupolas, for hundreds of men are compelled to use them, and will be for years to come.

Arithmetic of the Screw and of Symmetrical Rings—IV.

By LEICESTER ALLEN.

We can now reconstruct Rule IV., given in the second article of this series, for finding the content of a single convolution of the interspace in a V-threaded screw, and substitute for it the following shorter one:

Rule IX.—From the content of a cylinder having the larger diameter and a height equal to the thickness of the base of the thread, subtract the content of a double frustum of a cone whose larger diameter is equal to that of the screw over all, whose lesser diameter is equal to that of the barrel of the screw, and whose height is equal to the thickness of the thread-base.

Example.—What is the content of a single convolution of the interspace of a screw having the dimensions given in the example under Rule VIII. ?

It will be seen on reference to Article III. that these dimensions were as follows: Diameter of screw over all, 3 inches; base of thread, ¼ inch; diameter of the core or barrel, 2½ inches.

First Operation.—The area of a cylinder three inches in diameter is 7.0686 square inches, and this multiplied by the thickness of the thread-base gives us $7.0686 \times 0.25 = 1.76715$ cubic inches.

Second Operation.—The content of the double frustum of the cone having the given diameters and height, we found, in the example under Rule VIII., to be 1 48898 cubic inches, and subtracting this from the content of the cylinder we have $1.76715 - 1.48898$ cubic inches $= 0.27817$ cubic inch, which is the desired content of a single turn of the interspace.

We can also reconstruct Rule V., given in the same article, for finding the content of one turn of the interspace when the thread-bases do not abut.

Rule X.—Find by Rule IX. the content of a single turn of the interspace of a screw having the same diameters and dimensions of thread, and in which the thread-bases abut, and to this content add the content of a ring of rectangular cross section having the same diameters and a height equal to the distance the thread bases are separated, as measured on a line parallel to the axis of the screw.

Example.—A conveyor screw has a diameter 5 inches over all; barrel, ¾ inch diameter; thread, ¼ inch thick at base and $\frac{1}{16}$ inch at outer perimeter, and a pitch of 4 inches. What is the content of a single turn of the interspace ?

Laying out to scale, as in Fig. 17, a cross-section of the interspace *e b d f*, made in a plane coinciding with the axis of the screw, the scale in the figure being ½ size, we find that the interspace may be considered as composed of three rings, *e a b* being the cross-section of the upper one, *c d f*, the cross-section of the lower one, and *a b c d* being the rectangular cross-section of the intermediate ring. Also, we see that the sum of the contents of the upper and lower ring must equal the content of an interspace of a screw having abutting thread-bases and the same cross-section of thread.

Applying Rule IX. for the first three operations we can find the content of the interspace of a screw with thread of like cross-section and abutting bases, and we proceed as follows:

First Operation.—The content of a cylinder 5 inches in diameter and ¼ inch in height, is $19.635 \times 0.25 = 4.90875$ cubic inches.

Second Operation.—The content of a double frustum of a cone (general form as shown in Fig. 14), its greater diameter being 5 inches, its lesser diameter ¾ inch, and its height ¼ inch, is

$$(19.635 + 0.4418 + 2.945) \times \tfrac{1}{12} = 1\ 918499$$

cubic inches.

Third Operation.—Subtracting the second result from the first we have 2.99 cubic inches, which would be the content of one turn of the interspace did the thread bases abut, as would be the case if the pitch were reduced sufficiently.

Fourth Operation.—Now proceeding as further directed in Rule X., we find the content of the intermediate ring of rectangular cross-section, its inner diameter being ¾ inch, its outer diameter 5 inches, and its height 3¾ inches (Fig. 17).

Area of circle 5 inches in diameter is 19.635 square inches, which multiplied by the height gives

$19.635 \times 3.75 = 73.63125$ cubic inches.

Area of circle ¾ inch in diameter is 0.4418 square inch, which multiplied by the height gives 1.65675 cubic inches.

The difference of the two last results will be the content of the intermediate ring which we find to be 71.9745 cubic inches.

Fifth Operation.—Adding this content to the content obtained in the third operation we finally obtain 74 9647 cubic inches as the content of a single convolution of the interspace in the screw under consideration.

The methods hitherto considered are samples of those by which such computations are more generally made. While simple and accurate they are somewhat tedious and laborious. A study of them is useful, however, as, in mensuration, such analyses of solids as have led up to the rules given are of great use. For some other forms of screw threads similar analyses would give us rules, but as there is a much shorter, elegant and general method of computation for *all forms* of thread and interspace, such forms as remain will be discussed under a general rule.

Ordinary arithmetical treatises on mensuration usually give a rule for computing the content of a circular ring, Fig. 18, whose cross-section, made in a plane coincident with the axis, *a b* is also a circle. Since a general rule for all circular rings whose cross sections are symmetrical to a line *c d* drawn through the center of the cross section and parallel to *a b* is just as easy to memorize and apply in practice as the special rule usually given for a ring having a circular cross-section, it is hard to find a reason for the selection of this particular form of ring and a special rule applied only to this form. A general and very simple rule will be given in my next and concluding article.

We have seen that the content of a single turn of a screw thread or of an interspace is equal to the content of a circular ring having the same diameters and like cross-section made in a plane coincident with the axis. It will also be evident, from inspection of Fig. 18, and those that follow, that a circular ring which has the same content as an external screw thread having any form of cross section whatever may be considered as the outer part of a ring of symmetrical cross-section, the vertical line *c d*, that divides the cross section into symmetrical parts, being coincident with the base of the thread, which line is also coincident with the outer surface of the barrel or core of the screw.

Thus, in Fig. 19, is shown such a symmetrical ring, the outer part of which has the same content as that of a V-thread on a screw whose diameter over all is *e f*, and whose barrel has the diameter *g h*.

It will also be seen by inspection of Figs. 21 and 22 (respectively illustrating the form of interspace in a screw having a semi-cylindrical thread, and that of a V-threaded screw), and comparing these figures with Figs. 19 and 20, that a circular ring having the same content as the interspace may be considered as the inner part of a ring of symmetrical cross-section, the line *c d*, Figs. 19 and 20, which divides the cross-section into symmetrical parts, being coincident with the outer extremities of the cross section of the thread. If, then, we can find a general rule or rules for obtaining respectively the content of the inner and the outer parts of a circular ring having any symmetrical form of cross section whatever, we shall be able by its use to compute the content of any form of screw thread or interspace. This discussion I reserve for the concluding article of the series.

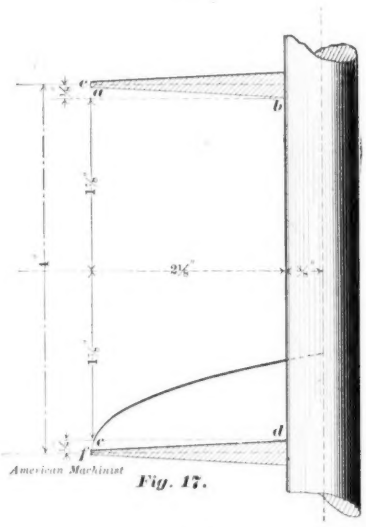


Fig. 17.

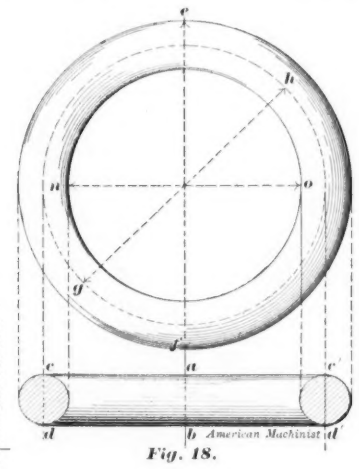


Fig. 18.

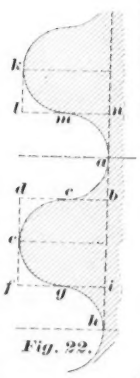


Fig. 22.

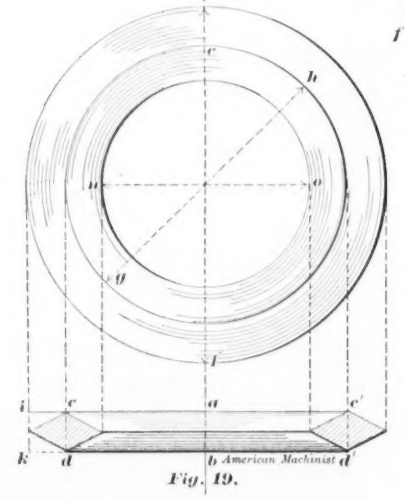


Fig. 19.

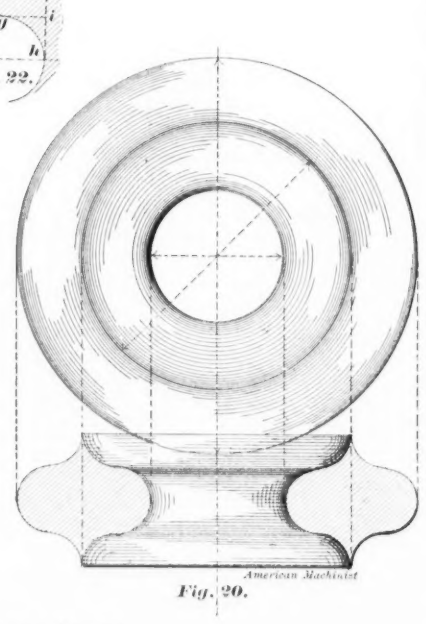


Fig. 20.

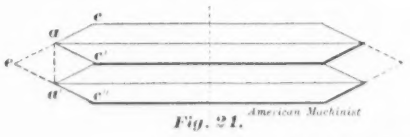


Fig. 21.

ARITHMETIC OF THE SCREW.

Fiber graphite Bearings.

By H. M. NORRIS.

Fifteen or more years ago it was demonstrated conclusively by exhaustive tests made at Stevens Institute that graphite of proper quality, free from frictional impurities, and properly prepared, approached nearer the point of perfection as a lubricant for general use than any other known material.

Rennie, as far back as 1827, found that graphite lessened friction wherever used. And Dr. Thurston, in his experiments at Cornell University, found that, when used with oil, it was well adapted for use under both light and heavy pressure.

Following these tests many attempts were made to produce a solid bearing material containing graphite, but the small quantity used in the experiments did not prove to be sufficient for satisfactory lubrication.

Five or six years ago Mr. P. H. Holmes took up the subject and performed such good and effective work in this direction that it finally took industrial shape.

The bearing material as made by Mr. Holmes is composed of selected lubricative natural graphite, wood fiber and water. To obtain the desired form it is solidified under heavy pressure in specially prepared molds. After being thoroughly dried the bearing is saturated with a drying oil, and then subjected to a current of hot air which oxidizes the oil and hardens the mass, when it may be machined with the same facility and tools employed on the metals.

This process gives a solid, self sustaining and thoroughly self lubricating bearing which is not affected by prolonged contact with water, oils, acids, alkalies, or change of temperature. And the usual niceties of fit and finish, and continuous oil supply, are unnecessary.

Mr. John H. Cooper, who largely assisted in the development of this anti-friction material, claims that "with fiber graphite bearings properly prepared and fitted to the supports and journals of machinery, the cost of oil together with all the appliances necessary to store, retain, convey and conduct the same to the bearings, is entirely saved.

"During the first revolution of the shaft its concavities are filled with graphitic particles which are worn off the bearings by its rubbing action upon it. When the surface of the shaft is completely covered and evened up upon its whole exterior, the sliding will be conducted thereafter wholly upon the newly formed graphitic surfaces, to which even the disengaged particles of the bearing will assist in lubrication; friction will, in consequence, be reduced to a minimum, and the shaft journal will be protected from subsequent wearing.

"If we start with roundness of shaft, and if we grant a certain roughness of surface, the journal after running a short time acquires smoothness by borrowing material from the bearing upon which it runs, and simultaneously fits itself the closer thereto, for its better support and running, after which the motion is all conducted upon the original and upon the acquired graphitic surfaces, with a measure of friction due to the natural lubricity of the graphite used, and without added lubricant of any kind or any attention whatever.

"The labor of cleaning and oiling and the cost of waste and wiping are saved, the soil-greasing of fabrics, machinery and buildings cannot happen, and the serious danger of fire from lubricating oils and the spontaneous combustion of them with discarded waste, are wholly removed."

It will be seen from this how superior the fiber-graphite bearing is to the old, troublesome and ever-requiring-attention bearing in common use.

There is, however, one important requirement which, to some extent, prevents its adaptation to all forms of boxes.

As before stated, the graphite and wood fiber are first mixed in water and this mixture pumped into a brass mold containing a great number of small holes and provided on the outside with grooves. The mold is then incased in a heavy frame and the mixture compressed by hydraulic pressure to about a third of its original bulk, the water passing out through the holes along the grooves and off. After drying in an oven, saturating with a drying linseed oil and baking until thoroughly hard, the piece is ready to go into its box.

If the box is split, recessed, and flanged in the customary manner for babbitting, the fiber-graphite may be secured in place, without trouble, by a cement filling. But where the box is solid, means must be provided for supplying the necessary end support which requires the use of flanged nuts or similar contrivance, to make room for which the complete machine may have to be re-designed.

A substance which will endure heavy pressure and will, at the same time, permit of its use without a lubricant is something engineers have been looking for for a long time. Fiber graphite approaches nearer this ideal state than anything yet discovered, and bids fair to usurp the berth now occupied by babbitt and the other anti-frictional metals.

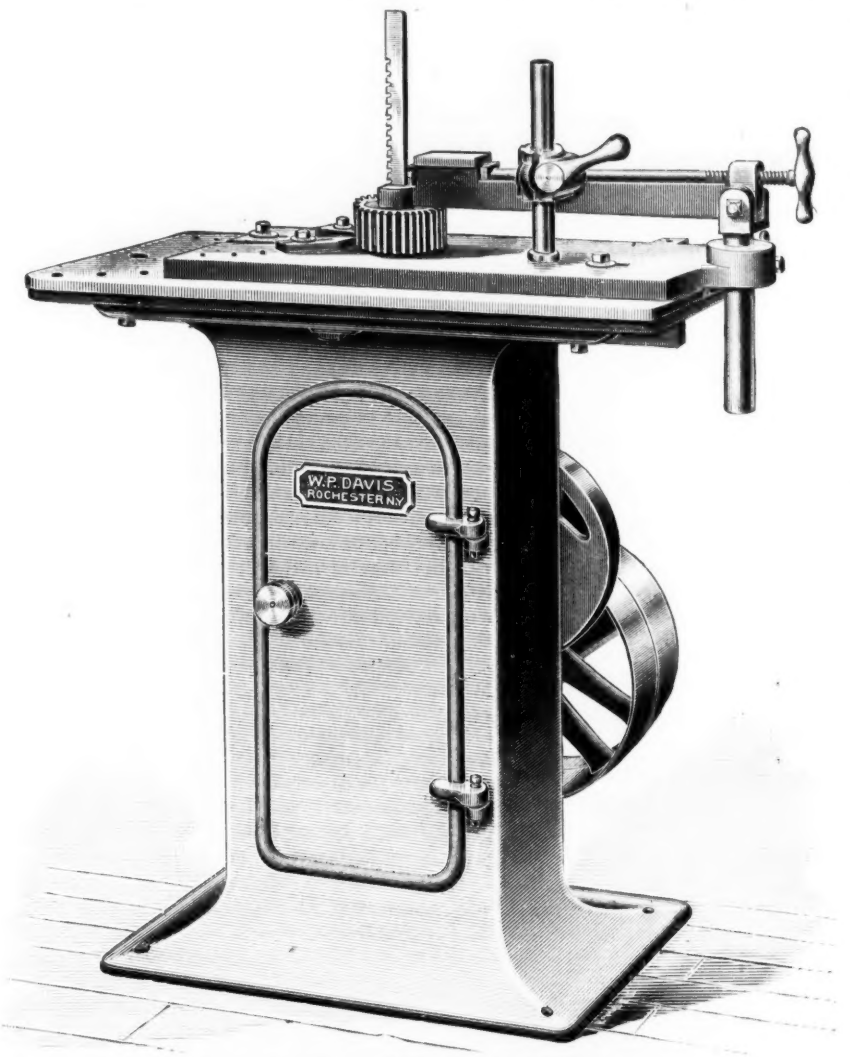
Three thousand three hundred and forty-one ships, of 7,659,000 tons, passed through the Suez Canal in 1893, yielding 68 millions in dues. According to the report of the company, about to be issued, passengers numbered 186,495, and yielded 1,864,000f., while sundry accessories yielded 384,000f., making a total of 71 millions. 3,082 of the ships, 92¼ per cent., passed through by night. The average duration of transit was 20 hours 44 minutes, of actual motion 16 hours 53 minutes. There were nine petroleum vessels. As to the nationality of the vessels, the English were 2,405, German 272, French 190, Dutch 178, Austro Hungarian 71, Italian 67, Norwegian 50, Ottoman 34, Spanish 29, Russian 24, Portuguese 10, Egyptian 5, American 3, Belgian 1, Brazilian 1, Japanese 1.

During the first two months of the year Belgium exported more than 86,000 tons of briquets made from coal dust. This is a large increase over previous years, indicating a growing industry.

Improvement in Key-seating Machine.

The engraving represents a new feature in key-seating machines, devised by W. P. Davis, of Rochester, N. Y., and applied to the machines built by the W. P. Davis Machine Co., of that city.

The improvement is in the nature of an extension of range of work to be done



IMPROVEMENT IN KEY SEATING MACHINE.

in considerable quantities especially, and, as shown, is a special table with clamping bar arranged especially for small work, such as key seating small change gears for lathes, small pulleys, couplings, etc. The table is so arranged that the work can be set to cut any taper of keyway desired, and any number of key seats can be cut the same depth and taper when the machine is once set. There is also a special new clamp and studs, not shown in the engraving, for heavy work. The feed mechanism on both style clamps is screw feed, with automatic relief to the cutter on the up stroke, which prevents the possibility of breaking the teeth of the cutter in backing up. The attachments can readily be fitted to any of the No. 1 machines made since 1882.

Emery Grinder.

The accompanying engravings illustrate an improved grinder built by the Norton Emery Wheel Co., Worcester, Mass.

In Fig. 1 the general form of the machine as regularly built is shown, the hoods being made interchangeable, so that they may be attached at any time. Fig. 2 shows the grinder complete with steel hoods in place. The main portion of these hoods is made of steel boiler plate, and they are fitted with malleable iron fronts through which the emery wheel projects. Each hood is adjustable for varying thicknesses of wheels, and is provided below with a dust receiver. Provision is also made to attach exhaust pipe. The hoods are pivoted near the base of the grinders, and the top ends are attached to the grinder rests, so that as the wheels wear down, and the rest is moved in the hoods are also properly adjusted.

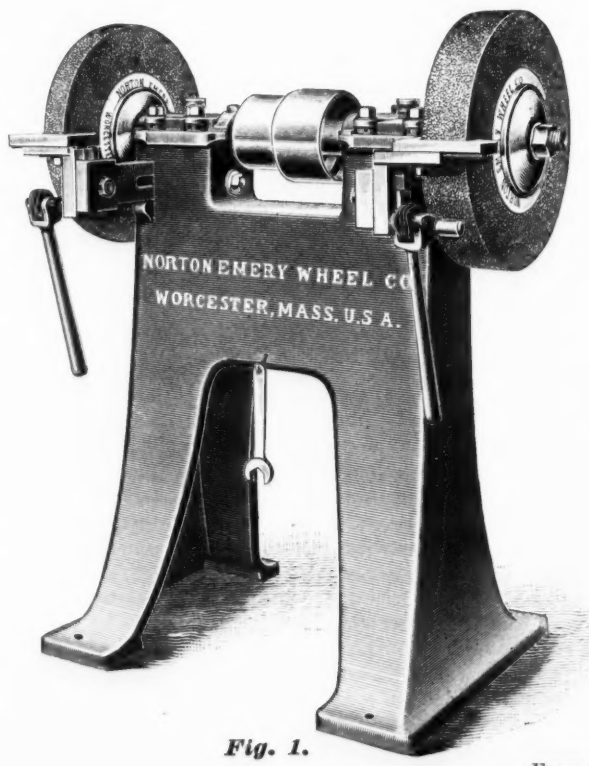


Fig. 1.

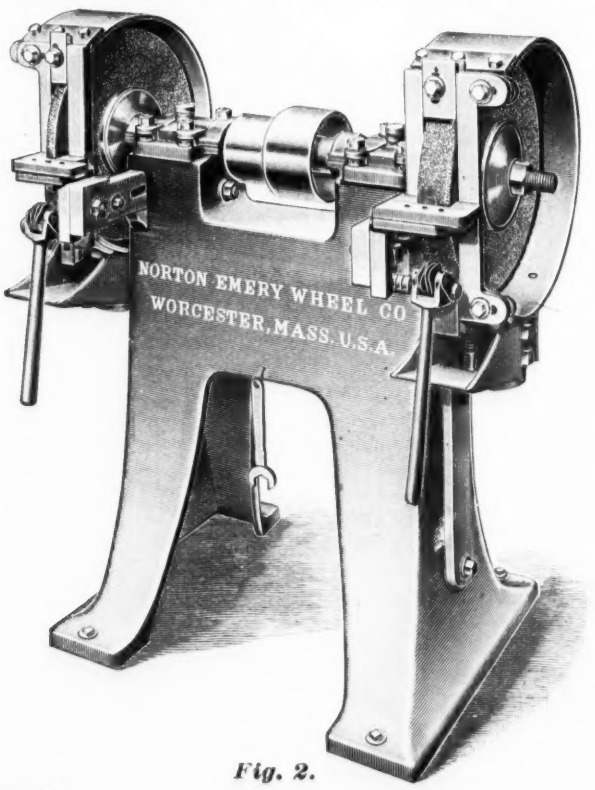


Fig. 2.

EMERY GRINDER.

The emery-wheel dressers form a special feature. Two of these accompany each machine, and are permanently attached to the rests, being always in position for use, and it is fair to presume that in most cases the wheels will be kept in better condition, and give better service on account of this arrangement.

No adjustment whatever is required for the dressers, as they move up to compensate for wear of the wheel in unison with the rests. The grinder rests are worthy of special mention from the fact that they possess important adjustable features. In addition to the usual vertical and horizontal adjustments, these rests are provided with extra sliding jaws so arranged that not only on the periphery, but on both sides as well the rest can be always close to the wheel, avoiding the danger arising from the catching of small pieces between the wheels and gaping rests. The rests are adjustable for wheels from ¼ inch to 3 inches wide, and are operated by the wrench shown upon the hook in front of the machine.

Another novel feature is in the adjustment of the spindle boxes. Strips of soft felt are used for liners, and each cap is supported upon four check nuts. When the boxes need adjusting the supporting nuts are lowered slightly, and the caps being tightened again compresses the felt liners and the wear is taken up without removing the caps, or running risk of getting grit into the bearings. The ends of the boxes are made absolutely dust proof, and each is made self oiling for a long period.

The grinder also has means of adjustment for end play of spindle, a feature not usually found in machines of this class. The machine is belted more powerfully than usual, and the entire machine is of a distinctly higher grade than is common with machines of its class.

The floor space occupied is 22 inches by 30 inches, distance between wheels 28 inches, entire length of spindle 39 inches, bearings 1⅝ inches by 7⅛ inches. It is designed to run wheels from 12 inches to 16 inches diameter, 3½ inches thick, or 18 inches diameter, up to 2 inches thick. Without hood the machine weighs 380 pounds, with hood 500 pounds.

It is said that a Swedish copper mine has been worked continuously for 800 years.

The Skilled Labor Market in England.

The labor disputes during April numbered, according to the Board of Trade memoranda, no less than 113; they were, however, chiefly of a local character and of short duration. On the whole, the state of employment shows an upward tendency, though not very marked, and partly, at least, seasonal in its character. In the forty five trade societies, with an aggregate membership of 352 806, making returns, 21,669, or 6 1 per cent., are reported as unemployed at the end of April, compared with 6.5 per cent. for March, and 6 3 per cent. in the forty-three societies making returns for February. In the pig iron trade, taking the country as a whole, employment has somewhat improved. Of the increase in the number of workpeople thus employed, over three-quarters is accounted for by Cleveland and Scotland. Employment in the steel trade has improved in most parts, but in a few districts steel workers are slack.

The engineering and metal trades show a slight diminution in the number of unemployed, the percentage in unions connected with these trades having fallen from 9.1 to 8.5.—*The Mechanical World.*

LETTERS FROM PRACTICAL MEN.

"Personnel of the Navy—The "Alabama."

Editor American Machinist:

Mr. Thornely, of Dubuque, Iowa, criticising my letter of May 10th in your issue of May 24th, "wishes to point out the fact that the 'Alabama' was built for a fast sailing ship, and under sail made 15 knots, while under steam she was simply nowhere; the engines were of unusual proportions, cylinders 24 inches diameter and 18 inches stroke."

These proportions may have been "unusual" to Mr. Thornely at that time, which leads me to think that he measured some other engine. We had plenty of engines in our service 30 inches diameter and 18 inches stroke, one of which I sailed with a year and a half. This engine, 2 cylinders, with 28 pounds boiler pressure, would indicate 350 horse power right along, using contractor's anthracite.

I have before me "a list of screw steamers in Her Majesty's navy," printed in 1860. Four pages of fine print with dimensions and powers of the engines are given, and, with a few exceptions, the ratio of diameter to stroke exceeds that 20 inches by 18 inches given by Mr. Thornely.

The ship while in England was only known as "290," that being the number of the order at Laird's yard. Of course, everybody in England, including Mr. Thornely, knew where she was going except the government civil service officials, who, the same as with us, never know any thing, except "officially," or else by the "back-stairs influence."

This little business operation brought the Lairds fifty thousand pounds, while the taxpayers of England were scooped something like two millions sterling, on account of the "Alabama claims," talked out of them at Geneva. This is the lesson for tax-paying nations: Be careful how you fool with war material in war times.

Captain Semmes in his book—and a very interesting book I find it—gives this description of his ship:

"She was of about 900 tons burden, 230 feet in length (over all), 32 feet breadth, 20 feet depth, and drew 15 feet of water with everything on board. Her engine was of 300 horse-power. Her propeller could be hoisted out of the water. Under steam she was ordinarily about a ten-knot ship. She was said on her trial trip to have made 11½ knots, but we never got it out of her. Under steam and sail both we logged on one occasion 18 knots and a quarter, which was her utmost speed."

Tons burden expresses very little to an engineer regarding the actual size of a ship, so I will try to find the actual displacement or weight in tons of 2,240 pounds. From Captain Semmes' figures I can call the water line length 10 feet less than the length over all, which leaves 220. Breadth 32, draught 15. 35 cubic feet = 1 ton of sea water, .52 = Constructor Pook's coefficient for vessels of this class.

Putting all these together we get

$$\frac{220 \times 32 \times 15 \times .52}{35} =$$

1,570 tons displacement.

I have not the dimensions of the "Kearsarge," but her displacement is given in the "Navy Register" as 1,550 tons.

The 300 horse-power alluded to was the "nominal horse-power" as used in England previous to the introduction of compound engines. It was calculated from a basis of 7 pounds pressure per square inch on the piston, and for the "Admiralty" 300 feet per minute piston speed. The horse-power was that of Watt 33,000 foot-pounds per minute.

With due respect to Mr. Thornely's actual measurement, I will show by calculation what I think must have been about the size of the cylinders of "No. 290." Assuming there were two cylinders with cranks at right angles gives 150 horse-power for each, then $\frac{150 \times 3{,}300}{7 \times 300} = 2{,}357$ = the area of the piston in square inches. From the table of areas of circles I take the diameter 54.8, or, say, 55 inches for the diameter of each piston.

Turning now to the list of screw steamers before referred to, I find a ship "Tribune" 300 horse power, Maudslay and Field, makers of engines. Diameter of cylinders 55 inches—exactly as I have given it—stroke of pistons 2 feet 6 inches = 30 inches.

The ratio of the diameter to the length of the stroke is thus considerably in excess of the figures 24 inches by 18 inches which Mr. Thornely thought unusual.

In those days, it was customary for builders, to guarantee an actual or indicated power of three times the nominal, which would make 900 horse power, and would give either the "Alabama" or "Kearsarge" the 10 knot speed which Captain Semmes gives. To get the other knot, requires hard driving with good fuel, good fires and engines well kept up.

Captain Semmes stripped his ship at Cherbourg and went out under steam alone. He says: "As for the two ships . . . they were of force so nearly equal that I cannot be charged with rashness in giving battle."

The "Kearsarge" was about seven miles out. The neutral line was three miles, and the French iron-clad frigate "Couronne" went out to watch that neutral line. Louis Napoleon, at that time emperor of France, was engaged in his conquest of Mexico, and was ready to strike us a nasty blow. That nasty blow we would have got if the "Alabama," coming out and finding her enemy too strong, had been chased within the neutral line only three or four miles away, for the "Kearsarge" would have been sunk by the "Couronne" and the "Alabama" got out of it with a few scratches. It is my belief—reading between the lines of Semmes' book—that there was something of that sort in his mind when he went out.

The preceding is a pretty long preliminary, which I hope, however, some of your readers may find instructive and interesting.

Here are two ships of about equal size, of similar and equal rigs, of equal nominal speeds and engine powers. The "Alabama," finding the fire of her enemy too strong for her, tries to get within the neutral line and under protection of the French guns; but the "Kearsarge," under the great work which her engines and engineers did on that day, was able to head her off and fairly to scoop her away from the neutral line and into neutral waters. The "Alabama" was sunk in an hour and ten minutes.

Captain Semmes, in his book, ascribes his loss to the fact that the "Kearsarge" carried chain cable armor amidships, of which he was ignorant when he went out. If he was ignorant, it was the first time in all that war in which he showed any qualification of that sort, and it was not because there were not plenty of people ready to inform him. As to the merits of that chain armor opinions differ; it was used on the Mississippi in 1862, and was evolved from the active brain of Chief Engineer Eben Hoyt, of the U. S. steamer "Richmond"—a Boston boy and long ago dead—so that the engineer in my writing comes naturally to the top again.

The two 11-inch guns of the "Kearsarge" were certainly superior to everything the "Alabama" had on board, a fact well known to Captain Semmes before as well as after the fight, yet he does not say so, which confirms me in the belief that there was a plot to lead her under the guns of the "Couronne" where she would have been smashed, guns, chains, and all. The battle was fought June 19th, just 30 years ago.

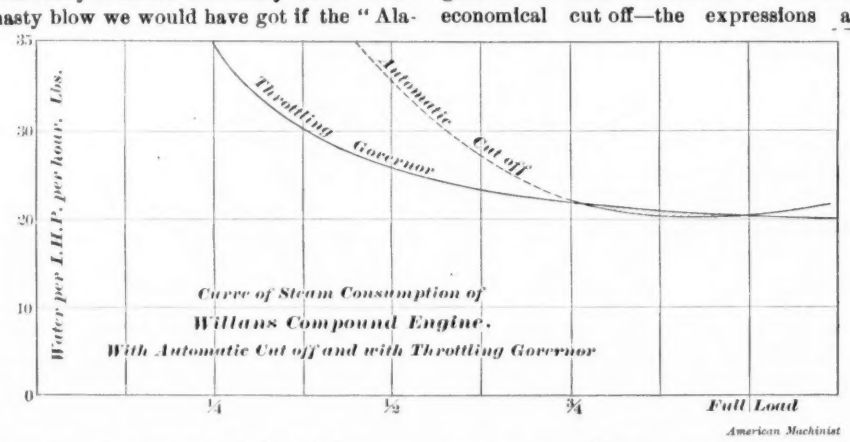
William H Harrison.

Throttling vs. Automatic Engines.

Editor American Machinist:

In reading through Mr. Booth's short article in your issue of the 31st of May on "Throttling *vs.* Automatic Engines," one feels that although all that Mr. Booth has said in regard to the throttling engine is perfectly true in the case of the larger proportion of engines manufactured (more especially single cylinder ones) still there is a great deal to be said for throttling on compound and triple-expansion engines even for light loads, especially in the case of the Willans engine which he so favorably mentions.

It is perfectly true that the method of running engines in a central station, as described by Mr. Booth, by coupling a number of units in parallel onto the mains is the best method of running throttling engines, but so also is it the best method of running automatic cut-off engines. That system was not arranged to suit throttling engines especially, but it was the outcome of careful study of load diagrams for the stations under consideration, and of the desire that every engineer should have to run his engine at its most economical load or most economical cut off—the expressions are synonymous. For every engine there is a most economical load, and, consequently, a most economical cut off, and it should be the aim of every one to run his engine at this load and cut off, consequently, for commercial lighting more especially, the station plant should be so divided up into units that they can be shut down as the load drops, or put on as the load rises, the steam economy being maintained at its maximum (approximately). How these units are arranged shows the capacity of the designer and his grasp of the conditions presented to him.



The writer agrees with Mr. Booth in his remarks as to the curious use of automatic cut-off gear on mill engines in the Lancashire cotton districts. In Bolton, Oldham and other towns there is no mill of importance that does not run at almost an absolutely steady load, yet, as he says, these engines fairly "bristle" with contrivances whose chief occupation is to make a noise. Indeed, some mill owners seem to think that an automatic cut-off has some occult influence on the engine economy, even with an absolutely steady load, and Messrs. Willans and Robinson when installing mill engines in these districts found it necessary in spite of their remonstrances to fit automatic cut-off gears, so great is the prejudice in favor of it.

It might be interesting to some of your readers (and I am sure it will be to Mr. Booth) if I give you some actual results of trials on the Willans engines, both with and without automatic cut-off. It must be understood that the Willans engine can be and is easily fitted with automatic cut-off gear if necessary or desired, but the exhaustive trials carried out by the writer under the directions of the late P. W. Willans show how little is gained by the use of such gear in the case of the Willans engine. The writer does not mean to affirm that there is no saving in certain portions of the load, nor does he wish it to be understood that every engine should use a throttling governor, but as the facts stand he is strongly in favor of throttling on compound and triple-expansion engines.

The curves given show the steam consumption of the Willans engine when used

1st. As an automatic cut-off engine, and

2d as a throttle-governed engine.

It will be seen that the saving is extremely small even at its maximum, and that at very light loads the throttling has considerably the best of it. Taking the extra cost of the valve gear into account it can be seen readily what inducement there is to use an automatic cut off.

The curves, of course, cross one another at full load as this is taken at the most economical point of cut off for a non condensing engine, but the remarkable thing about the comparison is the small amount saved from three-quarters to full load and the immense loss for all lighter loads than three-quarters. The automatic cut off, contrary to general opinion, gives exceedingly bad results at light loads when compared with engines governed by throttling, while at the point of maximum saving the difference is only about three quarters of a pound of steam per I. H. P. per hour, not sufficient to pay for the extra gear involved.

That there is a large field for automatic cut-off it would be useless to deny, and the Willans engine is fitted with this class of cut-off for street railroad work, but for central station lighting the throttling governor should be used on all engines which are either compound or triple-expansion.

The Willans engine is designed to use high pressures and is always a compound or triple-expansion engine. It seems to the writer folly where coal is even of moderate cost to use a simple engine with a steam consumption of 35 to 40 pounds per I. H. P. hour when by an increase of boiler pressure and the use of compound engines the consumption can be got down easily to 20 or 22 pounds per I. H. P. hour. Indeed, all the tendency is now toward these higher pressures and greater economy.

W. E. Burgess, A. M. I. C. E.

Draftsmen and Their Work.

Editor American Machinist:

"The careful draftsman never has a clear conscience; even in his idle hours if they may be called so, the ghost of a possible bull is constantly appearing to him." How those words, by "The Tramp," so completely express an often-felt condition, and, no doubt, they will be echoed in the minds of many draftsmen who read them. "Easy Way" may have drawn the case a little too strong, but there is much truth in what he says about those fellows who can calculate things to a mathematical certainty, and only those who are without actual experience in building machinery are able to exhibit that serene confidence in their work, which must be very refreshing to themselves. With draftsmen of this class there will be continual friction between them and the machine shop. Only a few of them ever find what the real trouble is, and when they do they absorb, as soon as possible, all the work-shop knowledge they can get, either by squeezing it from the shopmen by various means, or by actual work in the shop. I do not hesitate to say that it is impossible for any draftsman to command the respect or confidence of the shop mechanics, until he has learned by experience the wide gulf that separates the ideal machine on paper from the completely finished operative machine.

In speaking of draftsmen I mean that class of draftsmen who do more or less designing according to their ability and the conditions in which they happen to be placed, and I do not include those who are mere delineators whose trade it is to make drawings according to directions from the designer or from other instructions. There

are many men who are called draftsmen who are really good designers, and do a considerable amount of designing, but who also have to do much drawing that calls for nothing more than skill in drawing.

Of course, the difference between designing and making drawings is well known to the mechanic, but I am sorry to say many proprietors of shops do not seem to know it, or if they do, they have excellent success in concealing such knowledge, and seem to regard the drafting-room and its products as a sort of nuisance, tolerated only because insisted on by the new superintendent.

Of course, the time was when many shops of considerable size had no drafting-room and no drawings that could be taken to the machine shop to work by, but every shop that ever got up any machinery that was not a mere copy of some other machine, had some man who did the designing and made drawings or sketches, and this was generally done by the foreman patternmaker, who made his drawings directly on a smooth board. Those dimensions which were not shown on this drawing, he carried in his head, and furnished the information on call, to the foreman of the machine shop and others who needed it. Of course, the proprietor had to pay him for the time it took to do this, but his time was so affiliated with the patternmaking that it did not appear as a separate item in the wages account, and there was no drafting-room and white collared and ornamental draftsman visible, and everything was lovely. The proprietors who were accustomed to that way of doing things, never come to believe fully in the utility of the draftsman, and the same spirit clings to the machinists and blacksmiths who are expected to learn to read and work to drawings, and the result is antagonism between the machine shop and drafting-room.

The relations between the drafting-room and the shop would always be much more satisfactory if the drafting-room was placed in charge of a draftsman who has had some experience in all branches of the business from the pattern shop through to the final erection and operation of the machinery. And the head draftsman should have the authority and ability to run it in a systematic manner. I have seen a great deal of annoyance caused by allowing too much individuality in the making of drawings, and every sort of style of letters and figures, etc., were allowed to pass, so long as no actual mistakes were to be found. Many draftsmen have annoying faults due to the teaching they have received, and school draftsmen, in particular, are apt to be addicted to making faint lines, very small figures and ornamental styles of letters.

I quite agree with "Cogs," that it would be a good thing if draftsmen would contribute more frequently to these columns, and arouse discussion and comparisons of methods. With that end in view, I will suggest a code of rules to be enforced in the drafting-room, which I consider just about perfect. Of course, I expect some of our friends will not agree with me, but I will not admit that any of the rules are wrong unless they can prove it with good evidence.

1. Place the different views of the piece or machine so that each view will be adjacent to the side it is to represent.

2. Have a uniform system of sizes for drawings, and not more than three sizes for regular shop use.

3. All dimensions to be in inches up to 36 inches, and in feet and inches above that size.

4. Use the abbreviation ft. for feet, and no other designation. Figures not marked ft. are to be understood as inches.

5. Do not use center lines as dimension lines. Do not place dimension lines in a continuous line, but offset the lines wherever arrow points are, so that two arrow points do not come exactly together.

6. Always give total length dimensions in addition to intermediate sizes.

7. Use the plainest possible figures and letters and never make them less than $\frac{1}{8}$ inch high. Keep figures on open space as much as possible, and never try to crowd a number of dimensions in a small space.

8. Center lines and dimension lines to be in red ink.

9. Finish to be indicated by —*f*,—* with a little circle as shown on the line to be finished.

10. Always draw details to a large enough scale to show plainly and have room for figures.

11. Use dotted lines sparingly, and use them only when sure to make the drawing easier to read.

12. Always place the title, drawing number, dates, etc., in the same position, as near as possible on all drawings, and use ornamental titles only on drawings that are to be sent away for use of patrons.

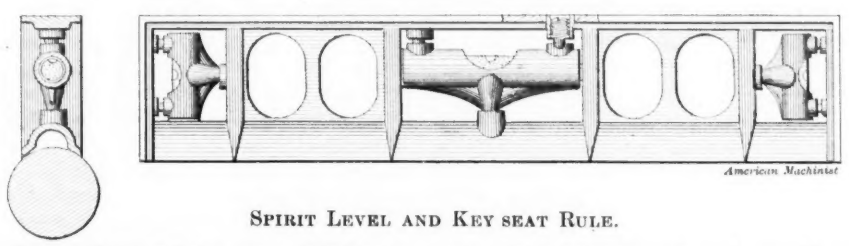
The above rules are of such a general character that they will apply to drawings for any sort of machinery that is built in a regular machine shop, but they may need to be supplemented by some additions to suit special circumstances. It may be necessary in some cases to designate the kind of finish desired, and this can be done by preceding the finish mark by another letter. For polished surface *p f**, for scraped surface *s f** and for file finish *f **.

It is understood that all drawings are made with a pencil and then traced on cloth so blue prints can be made for shop use. It is also understood that the drawings are to be so completely figured that no one outside the drafting room need measure them.

Where but few machines are built from one set of drawings, it costs too much to make special drawings for the machine shop, and there is generally serious objections to having so many figures on, which the machinist does not need, and which serve rather to confuse. I have used the plan of putting on small figures where they are needed by the patternmaker, and large heavy-faced figures for the machinist. This does very well, because the patternmaker generally makes a pattern drawing full size, and in doing so must study the drawing very closely, so that small figures are no serious objection to him. The patternmaker can also keep his drawing much cleaner than the machinist, and the figures are not so liable to be obscured by dirt.

Now, let the modest draftsman come forth with his massive store of knowledge and show the "practical mechanic" that he can write about what he sees, and does as well as the other can.

BELL CRANK.



SPIRIT LEVEL AND KEY SEAT RULE.

Piecework.

Editor American Machinist:

Mr. W. F. Brown's remarks, in your issue of May 31st, have touched a field which has been operated in a most serious manner to the disadvantage of the better class of machinists. I admit that piecework may be beneficial to the manufacturer where machines, instruments or parts are manufactured in large quantities. A man, after some experience on a certain piece of work, will be able to accomplish it in half of the time any other skilled mechanic could do it. But whether the standard of workmanship will be maintained the same by piecework is another question. In my opinion, it will not. Most any mechanic is liable to make a mistake; if he is working piecework he will do his best to doctor the ill part which, in many cases, can be done so that it will pass an inspection of a capable and wide-awake foreman. Then, the instrument or machine is sent out and put into use, and in a short time the defective part will show. In some cases the machine or instrument is sent a great distance, and, as it would not pay to send it back to the manufacturer to have it repaired, it is done elsewhere. Who stands the harm?

On the other hand, if the man had been working day-work, he would have hustled out another part, saving the manufacturer's reputation.

Another bad feature of piecework is, that the man does not take the care of tools which is absolutely necessary to produce good work.

In my estimation, any well-regulated concern has no trouble in finding out how long it takes a man to make a certain part, and to convince the man that he has to do a fair day's work, without introducing the sweater system.

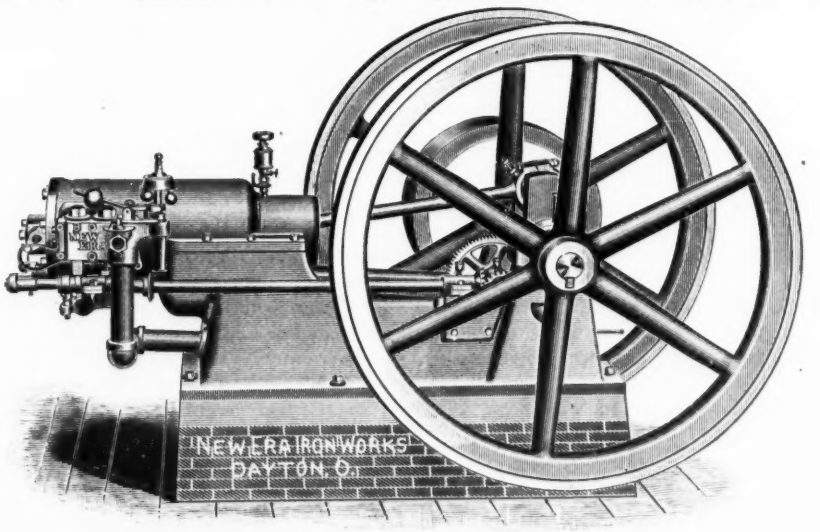
The piecework system has been introduced on tools by a concern for which I worked lately, and, as the circumstances under which it was done are very interesting, I will give a short description. The concern manufactures instruments which are considered as standards; their prices afford them profits from 500 per cent. upwards. The majority of their shop tools are of good make, but not taken care of, therefore, in a very bad condition, and, for the number of men employed, not sufficient; as a man has to wait sometimes from four to five hours before he can get the machine he requires, and then he has to go from one department to another where that particular machine is placed, carrying his small tools, material and drawings with him. The drawings are changed a number of times while working on the job. The rules adopted forced the man to go through a long string of red tape in order to get material and small tools. The work is expected in the limit of $\frac{1}{10000}$ of an inch. The superintendent who sets the prices is no mechanic whatever; he has been known to set a price on a job which exceeded three times its actual cost, and on other occasions to fix the price at one-quarter of what a man could make it for.

Is piecework justified in this case? I consider it a nuisance to the craft.

And finally, is there any mechanic who is able to say how long it will take to make a special tool, considering shrinkage and cracking by hardening, and other unforeseen delays which will occur?

M. FREDERICKS.

* The location of this little circle will be understood from the text, and will be indicated whenever it follows by a star.



GAS AND GASOLENE ENGINE.

Spirit Level and Key seat Rule.

With this we give an illustration of an adjustable spirit level and key-seat rule combined, invented and recently brought out by Fred. Schaefer, 334 Twenty second street, south, Minneapolis, Minn.

This level can be used for a variety of work, but it is especially well adapted to levelling shafting and setting vertical shafts. By means of the U-shaped side, the level can always be set in line with the axis of the shaft, and lines for key-seats can be very accurately drawn along the edges of the same side, insuring a parallelism of key-seat and axis of shaft. The glass holders are pivoted at their centers, and can be adjusted by means of the set screws opposite the pivots.

The level is comparatively light, and will be a useful tool for many purposes.

Gas and Gasolene Engine.

We illustrate herewith a new gas and gasolene engine in which admission, exhaust, etc., are controlled by poppet valves, and the governing is effected by the well known fly-ball governor driven from the same shaft that moves the valves.

The cycle of the engine is made up of the usual operation, *i. e.*, drawing in the charge of gas, compressing it, ignition and expansion, explosion or exhaust, these operations being performed in two revolutions of the crank-shaft.

Ignition is effected by a spark from a battery, which is easily kept in order, and it is claimed the engine is especially simple in construction and easily kept in working order. The governor automatically shuts off the gas, should the main belt break or the engine be in any way entirely relieved of its load.

The engine is adapted for either manufactured, natural or gasolene gas, and even in the case of the first named it is stated that a given amount of light can be produced more cheaply by using the gas in this engine to develop current to run incandescent electric lamps.

Gasolene is handled by the engine in such a manner as to be practically safe, a small pump taking up the required amount of oil (as determined by the governor), and forcing it into the air chamber where it is converted into gas and then admitted to the cylinder; all the oil thus taken up being used in the development of power.

The engine is built by the New Era Iron Works, Dayton, O.

The Berlin Iron Bridge Company have appointed W. E. Stearns their purchasing agent, to fill the vacancy caused by the death of Wm. H. Riley.

A press dispatch conveys the information that the "largest rope ever made" is being manufactured in a Massachusetts town. The size is given as three inches in diameter and 11 *inches in circumference.* Just what kind of a three-inch diameter rope is eleven inches in circumference is not stated.

We regret to learn of the death of O. A. Lanphear, member of the American Society of Mechanical Engineers. Mr. Lanphear was for some time in the employ of the Columbus (Ohio) Buggy Co., and later with the National Hot Water Heating Co., of Chicago. At the time of his death he was in business as an engineer in Columbus, devoting his time mostly to heating installation we believe.

AMERICAN MACHINIST

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FRED J. MILLER, }

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Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.

We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.

We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.

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NEW YORK, JUNE 21, 1894.

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Technical Education—Classification of Engineers.

Those who are in any way interested in technical education, will find much to interest them in the address of President Eckley B. Coxe, delivered at the Montreal meeting of the A. S. M. E., and published in full last week in our report of that meeting.

Mr. Coxe, for the first time, so far as we are aware, classifies engineers, according to individual capacities and nature of services performed, into business engineers, constructing engineers, managing engineers, theoretical engineers, and compilers or teachers. What he especially calls attention to is the fact that different natural qualifications and training are required for each of these, but that all should first, and as a matter of prime importance, be thoroughly grounded in the fundamental and underlying principles common to all engineering science and practice. In his opinion, engineering schools should teach thoroughly, at least as far as they pretend to go, mathematics, physics, chemistry, and the science of mechanics, leaving for subsequent experience and special training the development needed to make specialists in engineering, the idea being that this special training will be the more thorough and more readily acquired by reason of confining earlier study to the formation of a general and broad foundation.

Criticising the tendency to attempt to make competent machinists or transitmen by instruction in schools, given contemporaneously with study of science and theory, the speaker said: . . . "When a man receives a mechanical engineer's diploma from a first class technical college it should, and does, mean only that he has pursued with diligence and profit the branches of natural science which the experience of the men who have carefully studied the subject has shown are most useful to those who are to engage in the profession of mechanical engineering."

This is limiting the significance and importance of such a diploma much more than many friends of technical education will be willing to do, especially graduates of mechanical engineering schools or courses, but their consolation may be found in the further expressed opinion of the speaker to the effect that, other things being equal, a man with such a diploma—one which really means what it says, has a very great advantage over others.

There will be those who will dissent also from the opinions expressed regarding the higher mathematics, and especially the calculus. Mr. Coxe fully recognizes the plain fact that there are men capable of being, and who, in fact, actually are able engineers—men of whom the profession may well be proud, but who, nevertheless, are so constituted mentally as to make it impossible for them ever to master the calculus; while, on the other hand, some men who are adepts in mathematics including the calculus, are not and cannot become good engineers. This is, of course, in accordance with every-day observation, but there are those who dispute it, and claim that calculus is absolutely necessary to everyone who would call himself an engineer.

This we attribute largely to prejudice but partly also to the fact that they fail to recognize as Mr. Coxe does, that there are and must be specialists in engineering, and that it is necessary for some to thoroughly understand calculus, and many things besides, that would be absolutely useless to others.

The fact that the address was prepared and delivered by a man thoroughly educated in this country and abroad, who himself uses and enjoys the use of calculus, a "man of affairs," who in his business has very much to do with engineering in nearly, if not quite all of its branches, and constantly employs a number of engineers; in other words, a man very exceptionally well qualified to judge, has a tendency to disarm criticism and give much additional weight to his opinions. His personal experience has enabled him to look upon all sides of the question.

Unhealthy Occupations.

The saying to the effect that one half the world is ignorant as to how the other half lives receives confirmation in some of the reports, in relation to labor, that find their way into print; not the least interesting being those in relation to the effect of different occupations upon the health of those who follow them, these reports being prepared by medical men after careful observation.

For example, it is popularly believed that insanity, paresis, and kindred diseases principally affect those who are designated as brain-workers, in contradistinction to those who work with their hands. That these diseases do affect brain-workers for the most part is undoubtedly true enough, but the trouble is in understanding who works the brain hardest. There is reason to doubt that it is always, or generally, the business man or the professional man. As throwing some light on this, Dr. Spratling, of New York, writes upon fifty seven cases of insanity amongst the operatives in silk mills in a single city in New Jersey, finding that brain stress was the cause in nearly every instance. That is, the brain had been overtaxed by long hours in managing complex and delicate machinery, "one person sometimes doing the work of two or more in order to increase his earnings." The trouble appears to be that the brain is kept in an almost constant state of high tension, there being little relaxation in the grinding effort to make a living, the effect upon the brain being intensified by bad air and poor food.

Now, we venture to say that few ever thought that a favorable place to look for insanity and diseases of the brain was amongst the operatives in silk mills, yet such seems to be the case.

Outside of silk mills, it is, of course, well known that there are many unhealthy occupations, working at which men and women live but a few years at the most, and it becomes a question how far the State should interfere in the direction of ameliorating the condition of those compelled in their search for a living to work at such occupations. It is true—and will always be under present conditions—that men and women prompted by necessity will work under almost any conditions imposed upon them, conditions that result in physical wreck. If society has no other interest in the matter, it has a selfish interest in future generations that will spring up as the result of such conditions—the interest of self-preservation. Society has a right to demand interference for its own protection, and nowhere is this more essential than in this country, where there can be no class that is not of the ruling class.

In older countries a good deal of attention has been given to this subject. This is undoubtedly in part due to a greater necessity, owing to the more crowded conditions of these countries. Eventually, the matter will receive more attention in this country. So far as efforts have already been made, they have been in a measure successful; successful in a degree proportionate to the persistency of the efforts. This is notably true in relation to coal mining. An example of where but little has been accomplished is in the instance of the sweating system—so called—in the manufacture of clothes. There is room in many cities for energetic work in this direction, as well as in some other directions.

Not long since the failure of a Harveyized 18 inch plate at the proving grounds caused considerable comment, the belief of many, and amongst the believers the Bethlehem Company that made the plate, being that the Harvey process was a failure when applied to thick plates. It was said at the time of the test referred to, that there was reason for believing that the plate selected was not perfect, and at any rate it went to pieces rather ingloriously. Recently, a similar test was made of a 17-inch plate made at Bethlehem, which would appear to indicate that the first plate was defective. At all events, the plate recently tested stood the same test as the first one, the two projectiles being shattered, the penetration at a velocity of 1,858 feet being only nine inches. This result was, of course, eminently satisfactory. It will, however, strike an outside observer that, there being no positive evidence that the first plate tested was defective, not sufficient, as we understand the matter, to have led to its rejection, that plates similarly defective may, notwithstanding all pains that may be taken, find their way into use. This is something that cannot be avoided, and is a weak point in ironclad construction, just as there are weak points in almost everything. Of course, the plates tested are submitted to an ordeal through which they are not likely to pass in actual service, and equally, of course, every plate cannot be put to the test which alone can determine with absolute exactness its power of resistance.

The A. S. M. E. in Canada.

There is little doubt that there is a very general regret that the relatively few cities in Canada suitable for holding a meeting of the American Society of Mechanical Engineers makes it unlikely that meetings will often be held there, for a long time to come, at least. The recent experience of the society with Canadian hospitality and good fellowship is one that will be long and most pleasantly remembered. From the moment of arrival in Montreal to the moment of final departure nothing that the kindliest hospitality could suggest or the most open-handed generosity provide was neglected or omitted, and no honor, social or otherwise, was by the Canadians considered too great to be bestowed upon their visitors.

It is to be hoped that the result of this interchange of courtesies by influential men will result in much good to both sides. Engineering and science recognize no political boundaries, nor should they; nor is it true, as Senator Frye recently declared, that "Canadians hate Americans," a declaration which, though referred to in some of the addresses of welcome, was contemptuously dismissed as unworthy of notice by sane men. But if it were true, and the recent visit to Montreal and Ottawa showed how Canadians treat those whom they hate, then we are curious to know how they treat those whom they love.

It is pointed out that when the possibilities of power from Niagara Falls is fully developed on the American and Canadian sides there is probability of immense manufacturing concentration within a considerable radius round about the falls. Undoubtedly, there will be something of this kind, but reasoning from all analogy manufacturers will pay about as much for power within that zone as they will in other favorable localities. There will, of course, be the advantage that comes from a central development of power, such as might come from the establishment of large steam plants in the vicinity of cheap coal from which power could be distributed in a similar manner.

But the company controlling the power at Niagara will retail it for all it will bring, as a matter of course. It is safe to assume that "harnessing Niagara" will not have a very serious effect on the sale of steam engines, nor will manufacturers be likely to go very far out of their way to locate within reach of the power, at least, not until they are pretty well satisfied of the intention of the company to continue low rates.

The ladies attending the meeting of the A. S. M. E., at Montreal, were generally much interested in the models and machinery to be seen in the building, and especially in the testing machines. A number of them were among the interested observers of the transverse test of a spruce beam in the 100-ton Wicksteed machine, and after the beam broke one of them said: "Well, I am not much of an engineer, and, perhaps, therefore, should not attempt to criticise, but it does seem to me that it is entirely useless to build that great big expensive

machine to break a timber. Why didn't they just have a man take a saw and saw it in two? he could have done it quicker and the ends wouldn't have been so splintery."

The amended bill for bridging the Hudson River at New York, which has become a law, provides the way for a great undertaking in the line of bridge-building. The bridge must have a span of not less than 2,000 feet and more, if the Secretary of War so decides, and a minimum headway at the center of not less than 150 feet at high water. It is estimated that the bridge and its approaches will cost about $40,000,000. It must be completed within ten years. It is proposed that there shall be six railroad tracks across the bridge, and with these any railroad on either side of the river shall have a right to connect on equal and equitable terms, any disputes being referred to the Secretary of War.

In a paper on wire ropes read by Mr. Herbert Chursman, before an English engineers society, the author, in referring to the importance of lubrication, said that in an experiment an unlubricated stood 16,000 bends before fracture began, while a lubricated rope stood 38,000 bends over the same pulley.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(290) C. Y., Berlin, Germany, writes: I am well up in the English language, but am not sufficiently acquainted with the technical terms used in connection with machinery. Is there a dictionary of these technical terms translated into the German language? *A.*—We do not know of a dictionary that will suit your purpose exactly. Spon's "Dictionary of Engineering, Civil, Mechanical, Military and Naval," gives the technical terms in French, German, Italian and Spanish.

(291) R. D. T, Madison, Wis., writes: I have been following with considerable interest Mr. Begtrup's articles on the theory of steam engine governers. He says near the end of his article, in your issue of January 18th, current volume, that he has made a mathematical investigation of the subject. Could you tell me whether he has, at any time, published this in any of the scientific journals? *A.*—We know of no other mathematical investigation by Mr. Begtrup than those which appeared in our columns in subsequent articles treating on the same subject.

(292) W. J. E., Dansville, N. Y., writes: Please give me the locations of the U. S. Navy Yards? *A.*—Brooklyn Navy Yard, Brooklyn, N. Y.; Charlestown Navy Yard, Boston, Mass.; Gosport Navy Yard, near Norfolk, Va.; Kittery Navy Yard, opposite Portsmouth, N. H.; Leage Island Navy Yard, 7 miles below Philadelphia, Pa.; Mare Island Navy Yard, near San Francisco, Cal.; Pensacola Navy Yard, Pensacola, Fla. There are naval stations at New London, Conn., and Key West, Fla., and a torpedo station at New Port, R. I.

(293) W. M., New York, asks: Where can I obtain information relating to the different systems of optical telegraphs, especially that used on the New York elevated railroads? Are there any books, not too expensive, treating on this subject? *A.*—We suppose you refer to semaphores worked by electricity. We have not seen a book which treats on the different systems of these signals. Probably the best way to get the desired information is to send to the makers for a catalogue; the makers' address you will undoubtedly find on the signals, as some of these systems are patented.

(294) H. B. S., Malone, N. Y., writes: Kindly explain through your columns to what the gain in economy of a compound over a single expansion engine is due, both taking steam and exhausting at the same pressure. *A.*—Under the given conditions, there is no gain in economy excepting that due to a decrease in the cylinder condensation in the compound engine, which, in some cases, does not amount to much. The advantage of a compound engine is that a higher steam pressure can be used than in simple engines, and expanded to any desired degree with economy.

(295) J. T., Jacksonville, Fla., writes: I wish to make a roll 4 inches diameter to run in connection with a drum; the latter is run at the rate of 1,000, and the roll, 750 revolutions per minute. I want to cover the roll with something that will not give to the blows from the drum, which has angle irons on its periphery, but will retard the material that is to be fed through, and prevent slipping at the speed of the drum. The roll will have to be perfectly true, with smooth face. Do you know of such material? *A.*—We do not know of a material that will suit all the conditions named. We have seen rolls finely fluted, which were comparatively smooth to the touch, and perfectly true.

(296) R. T. T., Stamford, Conn., asks: How much coal would a boiler consume in a week running a five horse power engine 12 hours per day? Please give a rule for computing the same. *A.*—If the construction of the engine is such as to use the steam as economically as possible, and a type of boiler is used which will give the maximum evaporation per pound of coal, from 6 to 10 pounds of coal per horse-power per hour will be required. Taking the latter estimate, 50 pounds of coal for 5 horse-power per hour will be consumed, and the consumption of coal during a week of 72 hours will be $72 \times 50 = 3{,}600$ pounds. This, of course, applies to small engines only. In large multiple expansion engines, the consumption of coal per horse-power per hour, may occasionally be as low as 1¼ pounds.

(297) C. G. E., Baltimore, O., writes: Kindly inform me where I can get the paper read before the American Society of Civil Engineers, by Robert Cartwright, entitled, "The Electrical Station of the Citizens' Light and Power Company." *A.*—Write to American Society of Civil Engineers, 127 E. Twenty-third street, New York. 2. I am also desirous of reading some thorough work on stationary engines and cost of steam production, treated from an American standpoint of practice. The only publications that I am aware of are English, and as far as they deal with the stationary engine are extremely unsatisfactory. Kindly refer me to some good book. *A.*—"A Manual of the Steam Engine," Part II., design, construction, and operation, by R. H. Thurston, A. M., LL. D., may suit your purpose. It is published by John Wiley & Sons, New York.

(298) J. C., Providence, R. I., writes: Kindly inform me what process is employed for making cold rolled shafting. Also, is the machinery required for the process made in any machine shop, or do manufacturers make their own tools? *A.*—In cold rolling the previously pickled bar is passed in a cold state repeatedly between highly polished chilled cast iron rollers, the reduction being controlled by frequent calipering. The general disposition of roll-train is the same as for hot rolling, but permits unusually accurate adjustment of the rolls. Round bars are rolled over and over in the same groove, and rotated slightly between passes, for, of course, only a short arc at the top and bottom of the groove can conform accurately to the section aimed at. Thus, at one mill round bars receive on an average from 30 to 40 passes each, with a total reduction in diameter of about $\frac{1}{32}$ inch when less than 3 inches in diameter, and about $\frac{1}{16}$ inch when larger. For further information on cold rolling we must refer you to "The Metallurgy of Steel," by H. M. Howe. Manufacturers of machinery for rolling mills can make the machinery for cold rolling process.

(299) C. ——, Erie, Pa., writes: Kindly explain why throttled steam becomes superheated. *A.*—In referring to steam tables you will find that the heat in a pound of saturated steam of any given pressure is greater than the heat in a pound of saturated steam of lower pressure. But a pound of steam throttled down to a lower pressure will contain nearly the same heat as a pound of saturated steam of the higher pressure, consequently it will have more heat than is necessary for keeping the steam in a vaporous state, and this excess of heat will superheat the throttled steam to a slight extent. 2. Does mercury or alcohol evaporate to any appreciable degree when not exposed to any higher heat than that of the atmosphere? *A.*—Under these conditions, mercury will not evaporate to any appreciable degree, but alcohol will evaporate. 3. How much more friction will there be than that of water, when mercury or alcohol flows through short tubes of small diameter? *A.*—The friction due to the flow of alcohol through tubes we believe to be the same as that of water; we have no data from which the friction due to the flow of mercury can be determined, but in our opinion it will be less than that of water.

(300) J. W. H., St. Louis, Mo., writes: Kindly give me a formula for computing the allowance for shrinking cranks on their shafts. We have a hydraulic press of 300 tons ultimate pressure, and I would like to know how much to allow for shrinkage on shafts varying from 3 to 24 inches diameter at any pressure up to 300 tons. *A.*—For shrinking cranks on their shafts, the eye of the crank is heated so that the hole is slightly enlarged by the expansion of the metal, and under these conditions there is generally no pressure required for putting a crank on its shaft. For small shafts 3 inches diameter, we should allow for shrinkage about .002 inch per inch diameter of shaft; this allowance should be decreased as the diameter increases; for a 24 inch shaft an allowance of .0015 inch per inch of diameter will probably be sufficient. For shrinking locomotive steel tires on their centers, .00106 inch per inch in diameter is allowed; we simply mention this to show the extent to which the allowance for shrinkage may be decreased as the diameter increases. Pressing the crank on a shaft by means of a hydraulic press is quite another matter, and no rule can be given for determining the difference in diameter of shaft and hole in crank to suit a given pressure; as much depends on the kind and quality of metal used, and upon the condition of the work. Nothing but experience will be of any service to you in work of this kind.

(301) P. E., Philadelphia, Pa., asks: How many actual pounds could a one horse-power steam engine raise when the connecting rod is connected direct to a winding drum instead of a crank disk? The diameter of the winding drum is equal to the stroke of the piston. *A.*—The number of pounds that this engine can raise will depend on the speed at which it is run. However, to make this plain, we shall assume that the stroke of piston is 6 inches, hence the diameter of the winding drum will also be 6 inches; the circumference of this drum is 18.85 inches, or 1.57 feet, and if the thickness of the rope is neglected, then the weight or load will be lifted 1.57 feet during one revolution. If now the engine runs at the rate of 200 revolutions per minute, then the load will be lifted through a distance of $1.57 \times 200 = 314$ feet during one minute. One horse power is equal to 33,000 pounds lifted 1 foot high per minute, hence the number of pounds which the engine can lift will be $\frac{33\,000}{314} = 105$. In this computation friction has been neglected. From this it will be seen that if the speed of engine is increased without changing the power, the number of pounds which the engine can lift will be less than found above, and if the speed of engine is decreased without changing the power, the number of pounds lifted will be greater than 105. Attaching the connecting rod to the drum or to a crank disk, will not make any difference in the load, so long as the speed of engine or diameter of the drum is not changed.

302) J. C. S., Norwich, Conn., writes: Kindly give me a formula for computing the load necessary for compressing a conical spiral spring made of flat steel 1⅝ inches wide and ¼ inch thick; the load is to compress the spring ¼, ½, ¾ etc. inch. I have been unable to find any information on this subject. *A.*—In the "Constructor," a hand book of machine design, by F. Reuleaux, the following formula is given for finding approximately the deflection:

$$f = \frac{3}{2} \times \frac{P\ R^2\ l}{G} \times \frac{b^3 + h^3}{b^3\ h^3},$$

in which f = deflection, P = load, l = the developed length of spiral, G = the modulus of torsion = ⅖ modulus of elasticity, and may be taken at 16,800,000 pounds, b = thickness of steel, and h = width of steel. 2. Please give me a formula for finding the area of a step when the speed is as high as 4000 revolutions per minute. For example, the weight of the spindle, pulley, etc., is 150 pounds, speed 4,000 revolutions per minute, what should be the diameter of the step? The step is immersed in oil, is made of gun metal, the spindle is of steel? *A.*—The usual practice is not to allow the pressure on the step to exceed 50 pounds per square inch, under these conditions the diameter of the step is found by the following simple rule: Multiply the allowable pressure per square inch of step by .7854; divide the total weight on the bearing by the product obtained, as above, and find the square root of the quotient, the result will be the diameter of the step.

$$\sqrt{\frac{150}{50 \times .7854}} = 1\ 9 \text{ inches}$$

for the diameter of the step.

(303) P. L. A., Pembine, Wis., writes: The firm I am working for is about to build a roundhouse containing six stalls. It is to be built cheaply, as the firm will remain in the location but two years. We want the roof to be fire proof. We have had one burn down on us which was covered with wood, and sheathed inside with asbestos paper. The one we now have is covered with corrugated iron on 25 pound T iron. The corrugated iron has rusted away in five months, caused by the sulphurous smoke and gas, and the general dampness of the place, in fact, a can of lye rusted through it in one month. Please inform us of something reasonably cheap, fire proof, and non-corrosive. *A.*—It will be a difficult matter to build a comparatively cheap roof, and make it absolutely fire proof. The fire-proof feature of the all iron engine-house roofing, as usually made, will prove, as a rule, in case of fire, to be an illusion, the same as the bulk of so called fire-proof construction in buildings. In regard to these roofs, Mr. W. C. Berg, in his book treating on "Buildings and Structures of American Railroads," says: "Practice in this country has developed beyond peradventure that the proper roofing material to use is slate, or a tarred felt or gravel roof, as the sulphurous gases from the smoke of the engines destroy any other form of roofing material very speedily. If slate is used, a higher pitched and heavier roof has to be built which causes greater expense, and the building being so high, it is more difficult to heat in winter. But a slate roof is more durable, particularly if a first-class grade of slate is used, fastened with copper nails, and laid on two or three layers of building paper. A tarred felt, or tarred felt and gravel roof combined, especially the former, will allow of a very light roof construction; but it is not very durable against the weather, although it will withstand the gases penetrating to it from the interior of the house better than the usual metal roofing materials." Taking all the given conditions as given by you into consideration, we should build a tarred felt, or a gravel roof with iron trusses. Timber roof purlins, and the roof sheathing, while not fire-proof, if kept whitewashed, will not endanger the building seriously, provided the posts in the interior of the building are of iron. If the first cost is left out of consideration, we should use a slate roof with iron trusses.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

More on Generated Gears on p. 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St. N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Cheap second-hand lathes, planers, shapers, drill presses, punch presses, etc. S. M. York, Clev'd, O.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

The A. S. M. E. at Ottawa.

In accordance with the previously arranged programme, the members attending the meeting of the American Society of Mechanical Engineers at Montreal, with many Montreal friends, took a special train tendered by the courtesy of the Canadian Pacific Railroad, and at 7:30 A. M. Saturday, 9th, started for Ottawa, where, upon arrival at 11 o'clock, they entered a special train of electric cars placed at their service by the Ottawa Electric Railway Co., and were conveyed first to the saw-mills of J. R.

Booth, where the process of "manufacturing lumber" on a large scale was witnessed. The Ottawa River brings to this mill the raw material in the form of logs, which are floated in its waters and those of tributary streams for many miles. At the mills there is a considerable fall, which, coming over rocks of irregular formation, gives occasion for the use of the hand camera, and also furnishes power to saw up the logs, the sawdust floating away upon the water below the mills.

Arriving at the mill, the logs are lifted out of the water and drawn up into the mill by an endless chain with projecting spurs at proper intervals, and from that on are handled and sawn into planks or boards at a rate that seems incredible to one who watches the process for the first time; immense band saws being used in some cases, while in others old-fashioned sash saws, arranged in gangs, cut three logs into boards at one movement of the carriage, or two circular saws, set the right distance apart upon the same arbor, cut off a slab from opposite sides of the same log. The country seems to be full of logs, lumber and sawdust.

Near this mill is the power house of the electric railway named. It is a substantial stone building, under which are several large turbine water wheels which drive by suitable gearing belt pulleys, from which large generators on the upper floor are driven by belts. The power demanded by this service is very variable, and, facing the dynamos, there sits a man who, with his eyes constantly on the volt meters in front of him, regulates the power accordingly, by moving levers which cause the wheel gates to be opened or closed by power in accordance with the demands upon the line. It is stated that this sentient governor is the only one that has proven at all adapted to the service. Leaving here, the party again took the cars and went to the Parliament buildings, which are very beautifully located on a high hill at the side of the river. After an inspection of the buildings and grounds, which were much admired, addresses of welcome were delivered in the Senate Chamber by the Hon. the Premier, Sir John Thompson, and the Minister of Public Works, Hon. J. A. Ouimet. Both these addresses were very cordial and complimentary, and in the absence of President Coxe, were happily responded to by Secretary F. R. Hutton.

From the Parliament buildings, a long ride in the open electric cars, flying the American and British flags, brought the party to Rockliffe Park, where, in the grounds of T. C. Keefer Esq., a lunch was given by that gentleman, the long tables being spread under a large tent in a position affording a view of a wide sweep of country in the valley below. Here there were more speeches and exchange of compliments and courtesies.

After this there was a reception or garden party at Government House, upon special invitation of His Excellency Lord Aberdeen, Governor-General of Canada.

Those of the party who found it necessary to take the train Saturday evening for New York, did not wait for the special train returning to Montreal, and leaving Ottawa at 4 P. M., but left by the Canada Atlantic road at 3 o'clock. A new coal was being used in the engine, and "she would not steam," so that with slow running and stopping to take off the front plate and adjust the petticoat pipe, a connection at Coteau Junction was missed, and two carloads of people stood in the middle of a desolate prairie, and with appropriate remarks contemplated the prospect of being detained in the Dominion until Monday morning. But by dint of much telegraphing an understanding was finally arrived at by which the Grand Trunk train leaving Montreal for New York at 7.30 P. M., was held until the party arrived, which gave those who had remained in Ottawa to attend the Governor-General's reception an unexpected opportunity to take the same train. Quite a number embraced the opportunity to visit Quebec, the boat leaving Montreal for that place being held until the arrival of the special train from Ottawa.

Twin-screw Steamer "City of Lowell."

The twin screw steamer "City of Lowell" is nearly completed at the yards of her builders of hull and machinery, the Bath Iron Works, Bath, Me., and will probably be ready for a trial trip within a week or two. Her builders and designers expect very gratifying results in regard to speed; the stipulated contract speed is 20 miles per hour, but it is believed that unless other boats running on the Sound can make from 22½ to 23 miles per hour, they will be left behind.

The principal dimensions of the hull are: Length over all, 336 feet; length on load water line, 319 feet 10¾ inches; extreme breadth over guards, 66 feet 1 inch; molded beam, 49 feet 6½ inches; load draught, 13 feet; depth of hold, 17 feet 7 inches; tonnage, 2,400 tons. The hull is constructed entirely of steel, and has four water-tight bulkheads. The vessel has five decks, the lower, main, saloon, gallery, and hurricane deck. The lower deck, forward and aft of the machinery spaces, is devoted entirely to the crew and free-berth passenger accomodation; there are 90 free berths forward, and 102 aft, whilst forward of all, the crew, waiters, etc., 63 in number, are berthed.

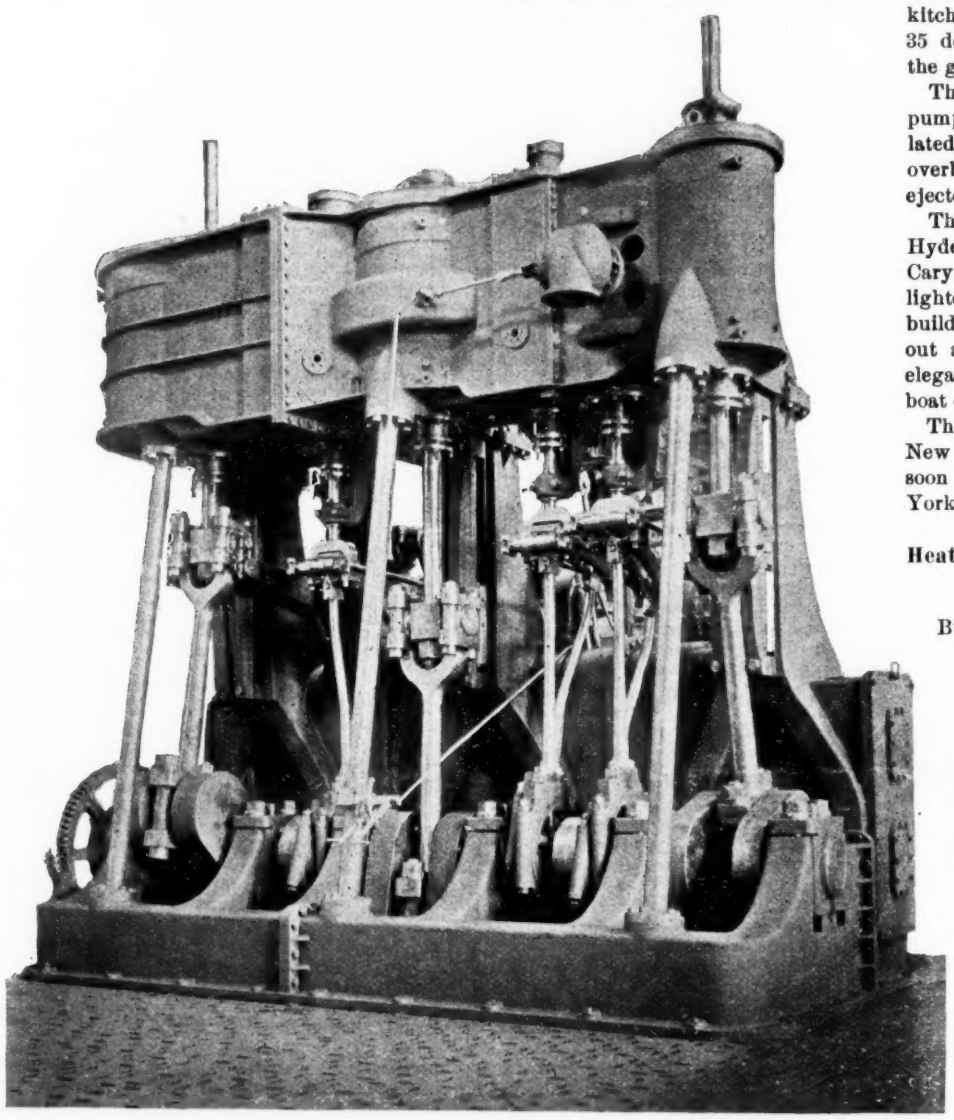
The accompanying deck plans (page 11) show the general location of staterooms, etc., on the main, saloon, and gallery decks. About 200 feet of the main deck amidships is devoted exclusively to freight, and is completely separated from the living spaces in all respects. On the after part of this deck is a commodious social hall, and aft of this is a hallway containing a handsome staircase to the saloon deck; also wash-rooms, and quarters for the purser and freight clerk. Aft of all this is situated the ladies' cabin containing six double-berth staterooms, 27 berths, and the necessary wash rooms, etc. The berthing accommodations for firemen and coal passers are located at the forward end of this deck.

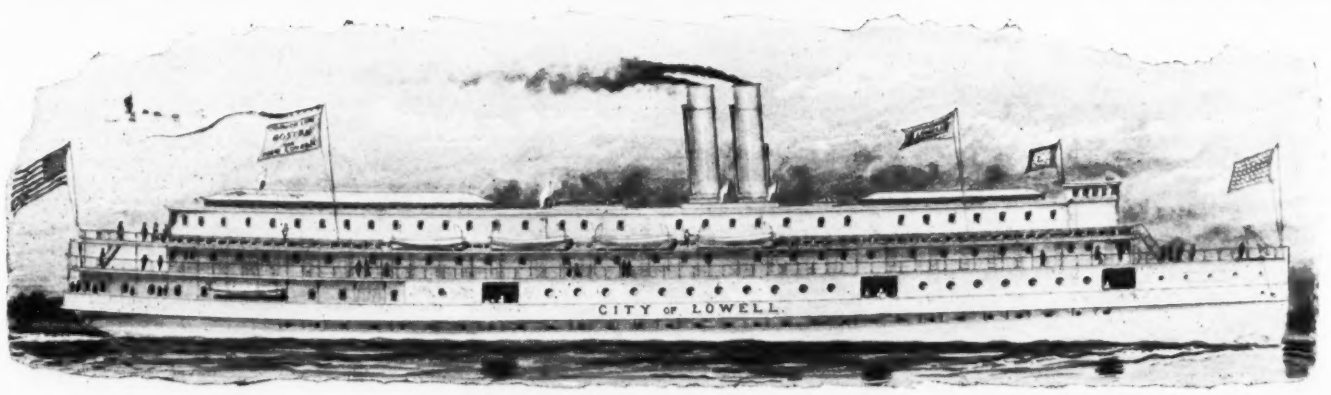
The saloon deck is entirely devoted to the accommodation of first-class passengers; there are 81 double-berth staterooms, and 25 rooms with bedsteads. The dining-room, kitchen, cafe, and officers' quarters, and 35 double-berth staterooms are located on the gallery deck.

The vessel is fitted with Worthington pumps throughout. The ashes accumulated during a watch are literally washed overboard by See's patent hydraulic ash ejector.

The engines were designed by Chas. E. Hyde, and the boat was designed by A. Cary Smith, of New York. The vessel is lighted throughout by electricity, and the builders have done their utmost to bring out a boat which cannot be excelled in elegance, comfort, safety, and speed by any boat on the American coast.

The steamer is built for the Norwich & New York Transportation Co., and will soon be placed on the route between New York and New London.





TWIN-SCREW STEAMER "CITY OF LOWELL."

The general construction of the main engines, of which there are two independent sets, is shown in the accompanying illustration; they are of the inverted, direct-acting, triple-expansion type. The cylinders are 26, 40, and 64 inches in diameter; stroke of pistons, 36 inches. The high-pressure cylinder is fitted with a piston valve, and the intermediate and low-pressure cylinders, with double-ported slide valves. The total indicated horse-power, including all auxiliaries, is 4,650 when the main engines are running at the rate of 125 revolutions per minute. The piston rods are of steel, whilst the connecting rods and all working rods generally are of wrought iron. The air pumps are worked from the low-pressure crosshead; they are 27 inches diameter and 12 inches stroke. Each surface condenser has a cooling surface of 3,387 square feet. The crank-shaft is 11¼ inches in diameter; it is made of wrought iron, crank-pins of steel. The propeller wheels are 11 feet diameter, 15 feet 6 inches to 16 feet pitch. Steam is supplied by six single ended Scotch return tubular boilers, 13 feet 6 inches diameter, and 12 feet 10 inches long; each boiler has three corrugated furnaces, 43 inches internal diameter. The boilers are made of steel, and designed for a working pressure of 165 pounds per square inch. The engines, boilers and coal take up 74 feet of the vessel's length amidships; the total coal bunker capacity is 90 tons, sufficient for the vessel to steam one round trip.

Heat Units and Specifications for Pumping Engines.*

BY ALBERT F. HALL, BOSTON, MASS.

The writer's experience in connection with the *duties* of pumping engines has shown him that misunderstandings arise as to the meaning of a test based upon heat units, and he hopes that an explanation will not be unwelcome to those who have not given the matter special study.

In all measurements of comparison it is essential that a fixed and definite unit be adopted. The steam engine is a *heat engine*, and the unit adopted for the measurement of its performance is rightly taken as the *unit of heat*, and the number of foot-pounds of work performed per stated number of such units as the efficiency of the engine. It will readily be seen that coal can never be taken as a standard unit, as it is of a variable nature, and, even with any particular kind of coal, there are so many things connected with its use as to render it unfit to be chosen for measurement of comparison.

What is a *unit of heat?* This may be defined, according to the most modern views, as that quantity of heat required to raise the temperature of one pound of pure water from 62° to 63° Fahr. It is sometimes called a British thermal unit and abbreviated B. T. U.

It may be asked why the range of temperature is taken from 62° to 63°, instead of the

* Presented at the Montreal meeting (June, 1894) of the American Society of Mechanical Engineers.

usual range from 32° to 33°. In reply to this we cannot do better than quote from Professor Peabody's remarks in his book of tables of steam and other vapors: "Nothing is known about the specific heat of water from 32° to 33° Fahr.; consequently the commonly accepted value of the thermal unit is an ideal quantity inferred from the behavior of water at higher temperatures. It is more scientific to take an easily verified quantity for the standard; and there is practical convenience in choosing 62° Fahr. for the standard temperature, because it is near the mean temperature of the air during experimental work."

The temperature of water at its maximum density has also been taken as the standard, but the same remarks made about the specific heat of water from 32° to 33° Fahr. also applies to this case.

Professor Rowland's recent carefully conducted experiments have shown the *unit of heat* to be equivalent to the work of raising 778 pounds one foot high, or one pound 778 feet high. This work of 778 foot-pounds is called the *mechanical equivalent of heat*, and is usually designated by the letter J, from the name of Joule, who made many extensive experiments relating to it. The reciprocal of J, or one divided by 778, is designated by the letter A.

Why should we not take a pound of steam for our unit? Because the heat required for the generation of steam varies with the pressure, and it requires more heat to convert water of a given temperature into steam of 200 pounds pressure than into steam of 100 pounds pressure. The difference is not great, but it is enough to make such a unit of little value in accurate experimental work. For ordinary work it is sufficiently accurate. But why use such variable quantities as coal and steam for units when the *heat unit* is just as simple to obtain and use, and one which requires but little study to understand. It is certainly preferable to have a *standard*, about which there can be little dispute, and such points as have arisen are of such a trivial nature as to have no effect upon the practical question of the use of the *heat unit* as this standard.

In order to have a clear idea of the practical use of this unit, let us briefly study the generation of steam. The operation of the formation of steam from water of a given temperature may be divided into three stages:

First. Raising the temperature of the water to that corresponding to the pressure of the steam.

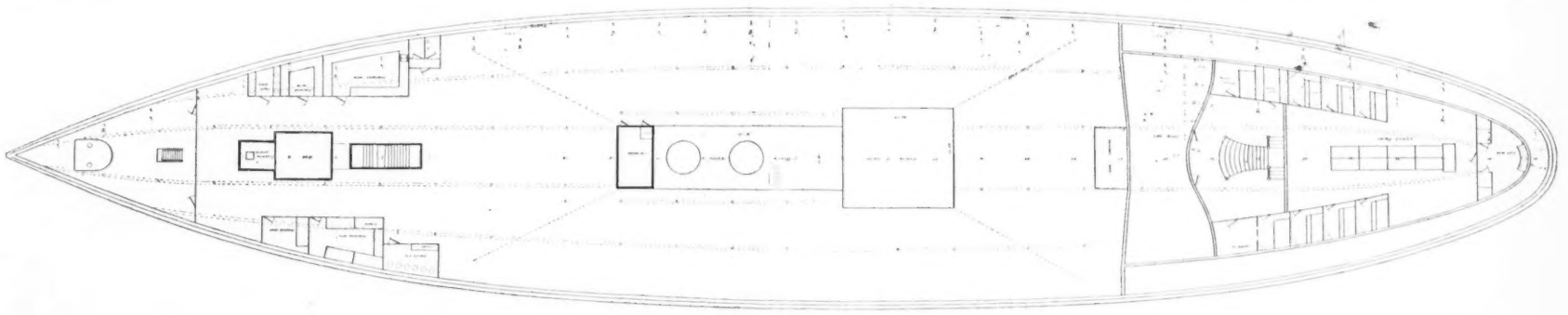
Second. Converting the water from this point into steam.

Third. Heating the steam and increasing its volume above that corresponding to its pressure at saturation, or what is commonly called superheating it.

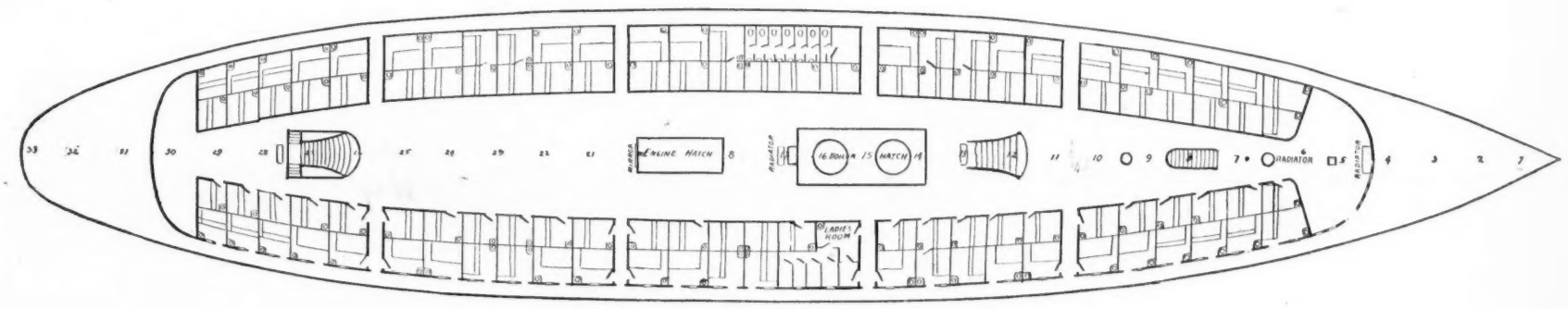
During the first stage, the heat which has been given to the water is more than that indicated by the thermometer, a small additional quantity, sometimes called latent, being required to obtain this temperature, that shown by the thermometer being called sensible.

During the second stage the amount of heat required is that necessary to overcome internal and external resistances.

During the third stage the heat is used to raise the temperature of the steam and increase its volume, its pressure remaining *constant*.



MAIN DECK.



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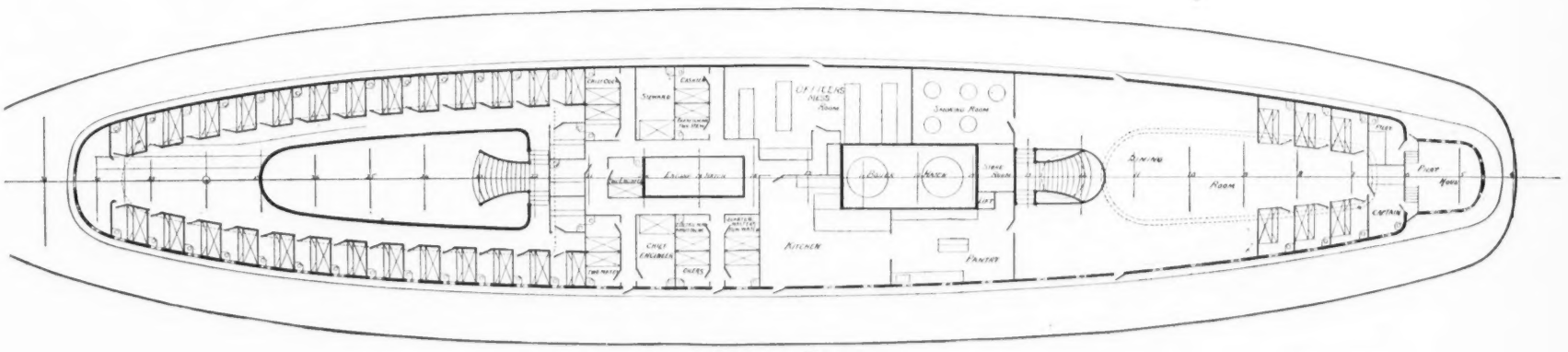

GALLERY DECK.

In tables of the properties of steam all quantities of heat are usually reckoned from the freezing point, or 32° Fahr., and the various stages are divided as follows:

The quantity of heat necessary to raise one pound of water of the temperature of 32° Fahr. to the temperature of the steam of a given pressure is called the *heat of the liquid* and is usually designated by the letter q, the temperature being reckoned from 0° Fahr. and indicated by t.

The heat used during the second stage is called the *heat of vaporization*, and is designated by r. This heat of vaporization is divided into two parts—that required to produce internal changes, and that for overcoming the external pressure or for performing external work. The first quantity is represented by the Greek letter ρ (rho), and the second by $A \times p \times u$—in which A represents the reciprocal of the mechanical equivalent of heat, as already explained; p the pressure in pounds per square foot, and u the increase in volume, in cubic feet, above that which the water had at the end of the first stage. $p \times u$ equals the number of foot-pounds of work done against the external resistance, in increasing the volume which the water had at the end of the first stage to that which it has when converted into steam. Now, if we divide this amount of work by the quantity of heat equivalent to one foot-pound of work, or, what is the same thing, multiply it by its reciprocal, we shall obtain the *heat equivalent* of the external work.

The heat used during the third stage is called the specific heat of steam under *constant pressure*, and is usually designated by c_p. Regnault found that for every degree Fahrenheit that steam is superheated under constant pressure 0.4805 of a thermal unit is required.

The total quantity of heat consumed during the first two stages, or that required to convert one pound of water of the temperature of 32° Fahr. into steam of any given pressure, is usually expressed by the Greek letter λ (lambda), and we have, consequently,

$$\lambda = q + r = q + (\rho + Apu).$$

Suppose, for example, that we have steam of 150 pounds pressure per square inch above zero, or about 135 pounds per square inch above the atmosphere, as shown by the gauge. The total heat required to convert one pound of water of the temperature of 32° Fahr. into steam of 150 pounds absolute pressure per square inch is given in Professor Peabody's tables as

$$\lambda = 1191.2 \text{ B. T. U.}$$

If we assume that the water at its entrance to the boiler had a temperature of 98° Fahr., then the heat required to raise water of 32° Fahr. to this temperature would be:

$$q = 66.01 \text{ B. T. U.}$$

Consequently

1191.2 less 66.01, or 1125.19 B. T. U.

has been given to every pound of water converted into steam of the pressure of 150 pounds per square inch above zero.

Let us also assume that calorimetric experiment has shown that only 98 per cent. of the water was converted into steam, or, in other words, that the steam contained 2 per cent. of moisture. In this case we have a mixture of steam and water, and must, consequently, make allowances, since less heat has been used per pound of water than that already obtained. The heat of vaporization of steam of this pressure is given in the tables as:

$$r = 861.2 \text{ B. T. U.}$$

Since 0.98 of a pound of water was converted into steam, then

$0.98 \times 861\ 2$, or 843 976 B. T. U.

were used in the formation of that part of the one pound of water which was converted into steam. The heat required to raise the temperature of water of 32° Fahr. to that corresponding to steam of the pressure of 150 pounds per square inch above zero is

$$q = 330 \text{ B. T. U.,}$$

and as *all* the water received this amount of heat reckoned from 32° Fahr., then

843 976 + 330 or 1173 976 B. T. U.

is the quantity of heat required to raise one pound of water from a temperature of 32° Fahr. to the temperature corresponding to the pressure of 150 pounds per square inch above zero, and to convert $\frac{98}{100}$ of a pound of water into steam of this pressure.

But, as the initial temperature of the water at its entrance to the boiler was 98° Fahr., and the heat of this water, reckoned from 32° Fahr., was, as we have seen, 66.01 B. T. U., we have the total quantity of heat imparted to the pound mixture of water and steam, as

1173 976 — 66.01 = 1107.966 B. T. U.,

instead of

1125 19 B. T. U.

required to convert all of the water into steam.

The understanding of this simple example is about all that is required fully to appreciate the calculations based upon heat units. There are, of course, allowances to be made in connection with various apparatus used; but such considerations belong rather to a thorough understanding of the apparatus than to an understanding of the calculations as such, and the *Transactions* contain ample examples of such applications in the report of the committee on duty trials.

In determining the quantity of heat used in the jackets care must be taken to avoid a common error. The steam in the jackets is condensed under *constant pressure*, and the heat given up by each pound of this steam is the total heat reckoned from 32° Fahr. required to generate steam of the jacket press-

ure, less the final heat of the water as it leaves the jacket, and not as some have put it, this amount less the heat $A \times p \times u$ required for external work.

Having now discussed the measurement of the heat used in the steam, we shall touch upon the question of duty.

The boiler and the engine should each be tested independently, for the reason that a good engine should not suffer from a poor boiler, or *vice versa*, and because, as these are often furnished by different makers, the merits of each ought to be known.

The rating of the "duty" of pumping engines upon the number of foot-pounds of work performed per 1,000,000 *heat units* was first suggested by Dr. Charles E. Emery,* member of this society, and this unit has been very wisely recommended by a committee appointed by this society to investigate the matter. It has in it the elements of simplicity, and places all engines upon an equal footing for comparison, which no other proposed method does.

It must not be forgotten that *coal* has nothing to do with it.

We are now prepared to examine two cases recently published in the specifications for pumping engines for two of our large cities, and to point out the errors. More might be cited, but these will be sufficient as examples. The first case is as follows:

"The duty required of the engine will not be less than one hundred and twenty million (120,000,000) of foot-pounds, with one hundred and forty (140) pounds of steam pressure at the engine throttle."

"The equivalent of one hundred (100) pounds of coal being taken as one million (1,000,000) heat units."

"The total number of heat units shall be measured from the temperature of the feed-water taken at a point where it enters the boiler, to steam of the temperature shown by pressure gauges on the boiler."

Nothing is said in the opening paragraph about the basis upon which the duty is to be made and the amount of duty and allowable steam-pressure are spoken of in an unsatisfactory manner.

The statement is then made that the equivalent of 100 pounds of *coal* will be taken as 1,000,000 heat units, which indicates that coal is to be estimated from the number of heat units used, the logic of which is not apparent, since the duty is really based upon heat, as will be shown by the formula given for its calculation.

There is not only an inconsistency as to the basis of measurement, but an error in the statement that the heat is to be measured to steam of the temperature shown by pressure gauges. Temperatures are not shown by *pressure* gauges. Compound gauges have been made where the temperatures corresponding to the pressures are given, but this is unusual, and as no such gauges are required by the specifications, the statement must be considered as somewhat careless.

The formula for duty is as follows:

$$\text{Duty} = \frac{\text{Foot-pounds of work done}}{\text{Total number of heat units consumed}} \times 1{,}000{,}000.$$

Now, it is easily seen that the matter of coal does not enter into the above computation, and the use of the expression is entirely unwarranted and absurd; the more so, since nothing is said in the specifications about weighing the coal.

Had the requirements for duty been worded as follows, no ambiguity would exist, and all would be simple and logical.

The engine must perform the work of not less than one hundred and twenty million (120,000,000) foot-pounds of work per one million (1,000,000) units of heat when running with a steam pressure at the engine throttle of one hundred and forty (140) pounds above the atmosphere, the heat utilized to be measured as follows:

Each pound of water fed to the boiler is to be debited with the heat required to raise *all* of the water from the temperature it has at its entrance to the boiler to that corresponding to the boiler pressure, and the amount of heat required to convert 97 of the water into steam of boiler pressure from the temperature corresponding to this pressure.

The formula for duty as already quoted can then be given.

The reason why the above directions "for the determination of heat utilized" have been given is because there is a clause allowing three per cent. for entrained water in the steam without explaining how this allowance shall be made.

This wording for the calculation of heat is of vital importance in principle, bearing in mind that the steam engine is a *heat* engine. The determination of *dry steam*, as has been done in several instances, by deducting the moisture bodily from the feed-water, when such moisture actually enters the cylinder, is entirely wrong. Although moist steam is considered detrimental to economy, if it enters the cylinder it carries with it *heat*, and in deducting such moisture we virtually debit the engine with less *heat* than it actually used, and the deduction has no *raison d'etre*. Such a deduction also shows a lack of knowledge of the real nature of the case, since there is no known law by which the injury from such moisture can be calculated.

It has been suggested that it would be better to give the duty per one unit of heat instead of 1,000,000, and thus still further simplify the work. The idea of having a basis which would be somewhat near the old coal basis was a good one, but we could easily become accustomed to the other.

Another case will now be cited. The specifications say:

* Page 21, Vol. VI., U. S. Centennial Commission International Exhibition, 1876.

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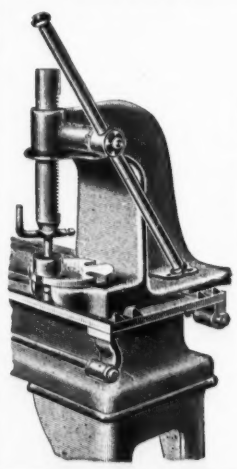

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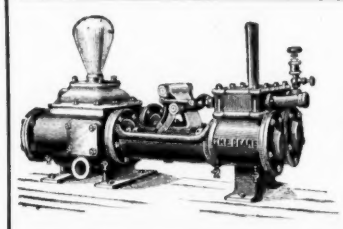

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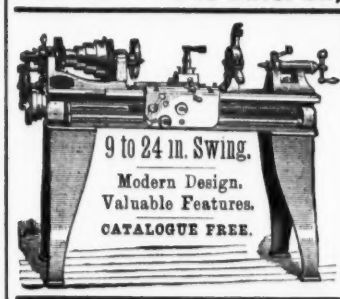

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"The contractor must guarantee that the engine shall develop a duty of a certain number of million foot-pounds, based upon an evaporation of ten pounds of water from and at 212° Fahr. per pound of coal."

This statement is very clumsy, and not only another misapplication of the use of coal, but another basis for calculating duty.

To convert one pound of water of the temperature of 212° Fahr. into steam of the same temperature, we require 965.8 B. T. U.

If we have used w pounds of feed-water, and have given to every pound of this water H heat units, then

$$w \times H$$

is the total quantity of heat used. The specifications ask us to ascertain how many pounds of water of the temperature of 212° Fahr. would have been evaporated into steam of the temperature of 212° Fahr., with the same expenditure of *heat*, which is found by dividing

$$w \times H \text{ by } 965.8$$

It then tells us to divide this by 10 and call it coal (it might as well have said straw). We are then directed to divide the foot-pounds of work done by this fictitious amount of *coal* and to multiply the result by 100, the final result being the duty obtained. In algebraic language this is simply

$$\text{Duty} = \frac{\text{Foot-pounds of work done}}{\frac{w \times H}{965.8} \div 10} \times 100$$

$$= \frac{1000 \times 965.8 \times \text{foot-pounds}}{w \times H \text{ (or heat used)}}$$

$$= \frac{965{,}800 \times \text{foot-pounds}}{w \times H},$$

which in simple language, is merely the duty in foot-pounds of work done per 965,800 units of heat.

What excuse can be given for basing the duty upon 965,800 units of heat, when that based upon 1,000,000 would involve less work in calculation, besides being in harmony with modern ideas?

It is hard for those not acquainted with the true nature of this matter to avoid the use of the *word* coal (coal itself does not enter into the requirements), and the object of this paper is to make the matter clear.

The writer would certainly advocate the appointment of a committee whose duty it shall be to frame a series of forms to be inserted in specifications for pumping plants to fit the various conditions likely to occur in practice.

These forms should not only be accurately worded from a technical standpoint, but should be expressed in simple and correct English, to avoid all misunderstandings.

Although the writer does not advocate the testing of pumping engines upon a *coal* basis, yet, as many do not hold the same views, it would be well to include *proper* forms for such a basis.

MANUFACTURES.

The Southern Mfg. Co., East Chattanooga, Tenn., are erecting a new building to its already large plant.

Cochran & Manus are to establish a plant in Chattanooga, Tenn., for making a new line of machinery.

Extensive repair and machine shops are to be erected by the Street Railway Company of Baltimore, Md.

William Smith and others have formed the Rotary Engine and Machinery Co., Chicago, with capital $100,000.

The new boiler house for the Coe Brass Mfg. Co., at Torrington, Conn., will be built by the Berlin Iron Bridge Co., of East Berlin, Conn.

The Southern Augur Bit Works, Harriman, Tenn., successor to the Bailey Augur Bit Co., has issued a price list of bits, augurs, etc., which will be of interest to those using such tools.

The Link Belt Machinery Co., Chicago, Ill., has issued a circular of elevators and conveyors for handling clay, tile, bricks, brickdust, cement, sewer pipe, etc. It is quite fully illustrated.

Leland, Faulconer & Norton Co., Detroit, Mich., write us: "Business is not especially bright with us, but we seem to be doing so much better than the average run of shops that we are properly grateful."

The Phosphor Bronze Smelting Co., Philadelphia, Pa., sends us a small folio circular, containing a list of phosphor-bronze alloys as suited to various purposes, with instructions for ordering either ingots or castings from patterns.

The Geyser Hydraulic Works is the name of a new company which has lately opened a shop at 491 East One Hundred and Thirty-eighth street, New York, for designing, building and repairing hydraulic, marine, and special machinery. H. Lysholm and C. Wigtel, Norwegian engineers, are the proprietors.

The new electric-light station for the Flatbush Gas Company, at Flatbush, N. Y., will be 60 feet wide and 73 feet long, divided into a dynamo room and boiler house. The roof of the building will be furnished by the Berlin Iron Bridge Co., of East Berlin, Conn., and covered with their patent anti-condensation corrugated iron roof covering.

The Link Belt Engineering Company, 49 Dey street, New York, write us: We have pleasure in advising you that our export business in the West Indies and in our limited territory in South America is materially increasing, and we have recently shipped to China 22,000 feet of the smaller sizes on an order from a well-known commission house here.

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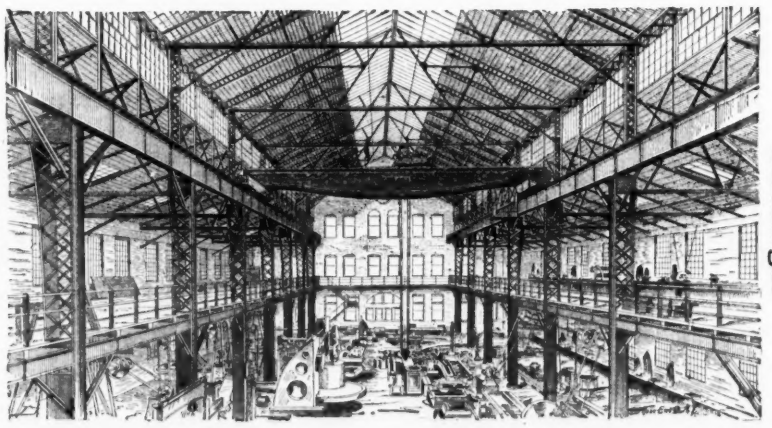

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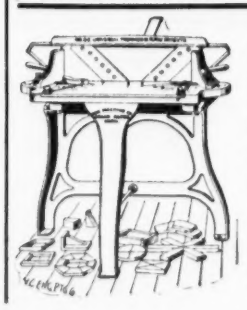

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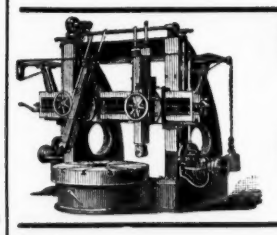

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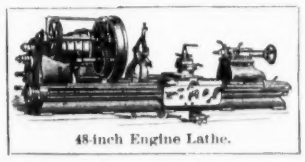

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Frank Kneeland Machine Co., of Pittsburgh, for one of their large three-motor electric traveling cranes, with an auxiliary hoist, which makes the second crane they have sold this well known concern. They have a large number of inquiries for their cranes now, and are quite busy in that department.

The Wood & Bishop Co., organized at Bangor for purposes of manufacturing and dealing in stoves and hardware, has a capital stock of $125,000, of which $25,000 is already paid in. John F. Colby, of Bangor, is president, and Chas. H. Wood, of Bangor, Me., is treasurer.

The Skinner Chuck Co., New Britain, Conn., has issued a new catalogue, in which their line of chucks is very completely illustrated and briefly described. This company has added several new chucks to its large line of manufacture. An excellent feature of the catalogue is the giving a number to every size and style of chuck made. This will be appreciated by customers in ordering, as it will save verbal description. The catalogue contains complete telegraphic code; it is standard size, and hence convenient for filing.

The following announcement is made: The exclusive agency for the sale of the Sterling emery wheel in this market, has been given to me, and a large line will be carried here in the future, so that the reputation this store has had in the past as being headquarters for everything in the emery wheel line will be fully maintained. When needing emery or corundum wheels, emery grinding machinery, or polishing supplies, kindly send your orders, as usual, to 174 Fulton street, New York, and they will be promptly executed by me. Yours respectfully, L. Best, Selling Agent.

Machinists' Supplies and Iron.

NEW YORK, June 16, 1894.

Iron—American Pig—We quote Standard Northern brands, No. 1 Foundry, $12.50 to $13.00; No. 2, $11.25 to $12.00; Gray Forge, $10.25 to $10.50. Southern brands are quoted at $11.50 to $12.25 for No. 1 Foundry; $10.50 to $11.00 for No. 2, and $10.00 to $10.25 for No. 3.

Antimony - The market is dull and weak. We quote L. X., 8¾c. to 9c.; Cookson's 10c. to 10½c.; Hallett's, 8.60c. to 8.62½c., and U. S. French Star, 10c.

Lard Oil—Prime is quoted at 58c. to 60c.

Copper—The market is dull. Lake Copper is quoted at 9¼c., but the demand is very light. Casting Copper is held at 8.65c. to 8.75c.

Lead—The market is firmer. Holders are asking 3.35c., and are unwilling to consider lower figures; offers are plentiful at this figure. There are buyers at 3.30c.

Spelter—The demand is slow; the prices are higher at 3.40c. to 3.45c., but these figures were barely sustained.

Tin—The market is dull and about steady at 19.75c. to 19.80c. for jobbing quantities.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

First-class machine draftsman wants engagement; uncept'l ability, skill & exp. Box 105, AM. MACH.

Draftsman, college graduate, with drawing-room and shop experience, wants position. Box 750 So. Manchester, Conn.

Wanted—Sit. by a first-class machinist and tool maker; some knowledge of drawing and designing special machinery and tools. Box 98, AM. MACH.

Mechanical engineer, large experience as salesman, making estimates and contracts, desires position. Address Box 103, AM. MACHINIST.

Machinist, 30, wants pos. as foreman or instructor in college or trade school; best of refs. from former position. "Instructor," AM. MACHINIST.

A 1st-class mech. dftsman desires a position as either dftsman, inspecting or erecting engineer, or will do work at home. Box 85, AMER. MACHINIST.

Mechanical Engineer—Young man who has had a varied and extended experience, and who is well informed on shop methods, costs, etc., desires a position. Energetic, care AMERICAN MACHINIST.

Situation wanted by a firss-class all-round machinist experienced on engines, general and special machine work; can do forging if required. Address Box 106, AMERICAN MACHINIST.

Situation wanted by a first-class toolmaker, experienced on jigs, cutters, dies, fixtures and fine special machinery; fair draftsman; have had charge of work. Box 107, AMERICAN MACHINIST.

Mech. & hydraulic eng., who has his own design for turbines, giving high efficiency at part gate, wants pos. with firm willing to build them; has graduated in civil eng. at European college; 16 years' in the trade. Successful, AM. MACHIN'ST.

Mech. engineer and draftsman, technical education abroad, 9 years' exp. in the U. S. in designing and working out details of marine eng. and iron structures, is open for engagement. Does not object traveling. Best refs. L. Emery, AM. MACH.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Wanted—To buy good second-hand tools. Box 89, AMERICAN MACHINIST.

Machinist wanted with tools, to take part of shop with patternmaker; shop in best locality in New York City; a chance for good mechanic. Box 102, AMERICAN MACHINIST.

An old established New York house desiring to increase its business would become agents for some desirable line of machinery. Box 104, AM. MACHINIST.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

An engineer's widow has a comp'ete set of back volumes of the AMERICAN MACHINIST since 1881, which she wishes to sell. Some of the volumes are bound and some unbound, but every number is in perfect condition. Address Administratrix, care AMERICAN MACHINIST.

Do you want a picture of the famous Locomotive "999?" Send 50 cents for our fine copper plate *transparent* picture (14x28), showing all parts *inside* and *outside*, all named and numbered, on satin gloss paper, for framing, educational, beautiful, correct. Locomotive Engineering, 256 B'way, N.Y.

Information Wanted—Advertiser is a 1st-class tool maker, die maker, and expert machinist. Also a good d'tsman and designer of mach'y. Is seeking location to establish a small jobbing machine shop where there is reasonable prospect of success. Information acknowledged with grateful thanks. All letters answered. Wm. E. Piper, 7639 Drexel Ave., Chicago.

CLEVELAND TWIST DRILL CO'S. GRIP SOCKETS.

No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before. No charge for the groove in the shanks.

Send for Descriptive Price List.

Cor. Lake and Kirtland Sts., Cleveland, Ohio.

Lathes, Planers, Drills, Shapers,

Boiler Tools, Steam Hammers, etc.

Now remaining unsold in the Engine and Boiler Shop, will be closed out at once.

IRON PLANERS.
19 in. x 3 ft Wheeler.
20 " x 4 " Lathe & Morse.
24 " x 4 " Blaisdell.
24 " x 5 " New Haven.
24 " x 6 " Powell "Latest."
26 " x 7 " N. Y. S. Eng. Co.
26 " x 8 " Pease.
30 " x 10 " Pease
32 " x 6 " Wood Light.
36 " x 10 " Gleason.
60 " x 24 " Heavy Pattern.

SHAPERS.
6 in. Stroke, Crank.
8 " " Gould.
9 " " Hewes & Phil.
15 " " Hendey.
16 " " Gould & Eber.
22 " " Triple Geared.

DRILLS.
22 in. Swing Prentice.
26 " " Lodge & Davis.
26 " " Prentice Friction.
36 " " Cinti. complete.
48 " " Old Style.
Radial Drill, 86 in. complete.

MILLING MACHINES.
B & S No. 1 Universal with Cutters, Arbors, &c. A1 order
Garvin No. 3 Bk Gears auto. fd.
Cincinnati No 2 Bk. Gs. auto. fd.
Pratt & Whitney, "Lincoln."

ENGINE LATHES.
11 in x 5 ft. Phila.
13 " x 6 " Blaisdell.
14 " x 6 " Reed.
16 " x 6 " New Haven.
16 " x 8 ft. Putnam.
20 " x 10 " Fitchburg.
24 " x 7 " Otis
24 " x 12 " Putnam.
30 " x 10 " Prentiss, Taper.
32 " x 16 " Gleason.
35 " x 15 " Hewes & Phillips.
36 " x 18 " Improved Style.
48 " x 17 " Hewes & Phillips.
84 " x 18 " Lincoln.
Pit Lathe, 72 in.

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50 lb. Helve. Bradley. Up'g't.
300 " Steam, Ferris & Miles.
800 " " "
1200 " Drop with Lifter, Farrel F'd'y's Make.

BOILER TOOLS.
Rolls, 6, 8 and 10½ ft.
Boiler Shears, 30 in. gap.
Flange Clamps, 6 ft.

MISCELLANEOUS.
Acme, 3½ in. Bolt Cutter.
Bor and Turn. Mill, 38 in.
Vert. Turret Borer, B. & S.
Slotter, 10 in. Stroke.

J. J. McCABE,

SUCCESSOR TO E. P. BULLARD'S N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

BARGAINS IN SECOND-HAND MACHINERY.

ENGINE LATHES.
1 12 in. x 5 ft. Geo. Gage.
1 14 " x 6 " Bogart.
1 15 " x 6 " Fitchburg.
1 16 " x 6 " Perkins.
1 16 " x 7 " Bement.
1 16 " x 6 " F. E. Reed.
1 18 " x 6 " New Haven.
1 18 " x 9 " Pease.
1 20 " x 6 " Bullard.
1 29 " x 12 " Fifield.
1 37 " x 14 " Old Style.

PLANERS.
1 16 in. x 16 in. x 3 ft. Belden Machine Co.
1 22 in. x 22 in. x 4ft. L. W. Pond.
1 24 " x 24 " x 6 " Novelty Iron Works
1 24 in. x 24 in. x 10 ft. Pease Planer Co.
1 28 in. x 28 in. x 7 ft. N. Haven.

SHAPERS.
1 6 in. Boynton & Plummer.
2 10 " Juengst Crank.
2 10 " Wood and Light Traverse head.
1 15 in. Juengst Friction.
1 18 " Putnam Traverse head.

HAND LATHES.
4 10 in. x 41 in. Garvin.
1 11 " x 4 ft. F. E. Reed.
1 11 " x 4 " Standard.
1 12 " x 5 " Back Geared.
2 20 " x 6 " " "

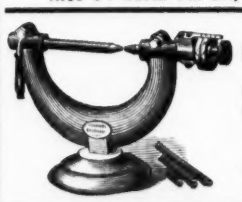
MISCELLANEOUS.
1 6 in. Bement Slotter.
1 42 " Gould & E. Automatic Gear Cutter.
2 16 in. x 5 ft. Gage Square Arbor Fox Lathes.
1 5 in. Cutting-off Machine.
1 3 " Armstrong Pipe Machine.
1 No. 2 Springfield Tool Grinder.
1 " 4 " " "
1 30 in. Squaring Shear.
1 No. 2 Pratt & W. Die Sinker.
1 " 3 Garvin Cutter and Tool Grinder.
1 " 2 Garvin Cutter and Drill Grinder.
1 " 1 Slate Marking Machine.
1 " 1 Brown & Sharpe Surface Grinder.
1 2 in. Begnall & Keeler Pipe Machine.

Also, a large number of other machines. Write for complete list and detailed description.

THE GARVIN MACHINE CO.,

LAIGHT & CANAL STS., NEW YORK.

Also 51 North 7th St., Philadelphia, Pa.



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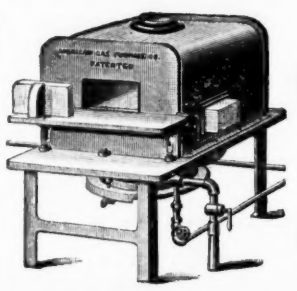

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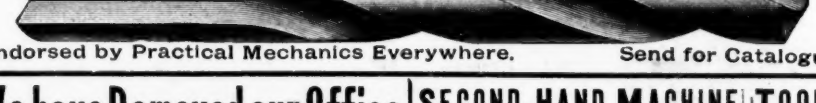

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SECOND-HAND MACHINE TOOLS

FOR SALE AT LOW PRICES.

50 Driving Wheel Lathe. N. Y. S. E. Co.'s make. *Fair order.*
36" x 36" x 10' Sellers Planer, single head. *Good order.*
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26" x 8' Pratt & Whitney Chucking Machine. *Very good order.*
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With F. B. Manville's Patent Sliding Former,

For making articles from the coil, of either round, half round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

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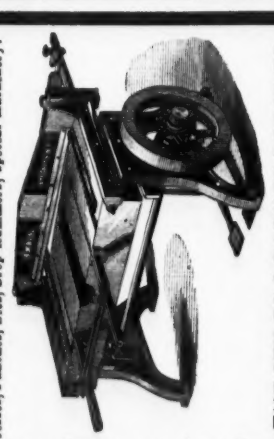

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FOR SALE.—Foundry, Blacksmith and Machine Shops, well equipped with tools, flasks, crane, cupola, ladles, scales, stock of iron for forgings, Reed & Pond lathes, 20-in. Lodge & Davis drill press, 16-in. Steptoe shaper, Sellers', 1-4-in. to 2 in. inclusive, twist-drill grinder, emery surfacing machine, emery key grinder, Smith-Silk planer (used 1 month and new from works), Le Count clamps, Morse reamers from 1-4 in. to 3 in. with handles for lathe use. Morse twist drills from 0 to 1 9-16 in., lightning stocks, dies and taps. All standard taps 1-16-in. to 1 1-4 in.; also square thread taps, 2 Harrington hoists 1 and 1 1-2 tons, angle plates, boring bars, pipe stocks, dies and vise, machinists' vises, chisels, 700-pound lathe, Jessop's tools, Jib crane for lathe, shafting, pulleys, hangers, crow bars, trucks, 4 pairs scales, 600, 800 and 5,500 pounds, emery stand, 36 fire extinguishers, dogs, lathe and flat drills, Cleveland T. D. Co.'s hand reamers, 1-4 in. to 1 1-2 in. inclusive, with full set of Morse drills to match, each 1-64 in. less than reamers, ratchet drills, belting, etc., all in first-class order. Will sell foundry or machine shop singly or together, or tools by piecemeal. Will sell to *machinery dealer* at a price that is right, if taken entire. A rare chance at a *reasonable figure* for a fine lot of tools. J. D. HAZLET, Big Rapids, Mich.

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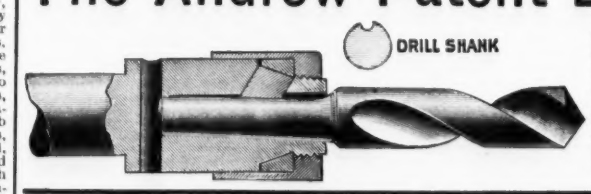
Book on Gears, 170 Illustrations, $1.00. Job Gear Cutting of all kinds, Spur, Bevel, Spiral, Ratchet, Worm-Rack, Elliptic, Index Plates, Noiseless, Fiberoid Gears, etc. Very small or large. Send for Catalogue. 1100 sizes of Gears.

The Andrew Patent Drill Chuck.



The original (not copied) device to prevent twisting off Tangs. No extra cost for ANDREW'S reverse incline groove in the shanks. Chucks made direct on new or old spindles. Holds heavy taper-shank tools from dropping out. Best Practical Chuck in the World. Endorsed by all prominent Twist Drill Makers and Mechanical Experts. Send for catalogue.

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Manufacture **AUTOMATIC SCREW MACHINES** for every variety of work. Samples of the production of these machines sent on application. We have about 200 of these machines at work in our factory, producing parts of Guns, Sewing Machines, Bicycles and Standard Screws.

We are also sole owners of and successors to the **CRANT ANTI-FRICTION BALL CO.** Our facilities in the production of **BALLS FOR ANTI-FRICTION AND OTHER PURPOSES** are unsurpassed in the world. **SAMPLES, PRICES AND CATALOGUES FREE.**

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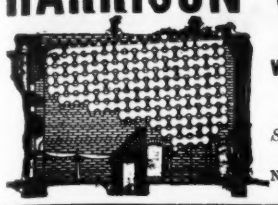

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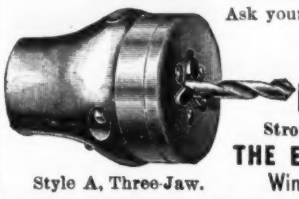

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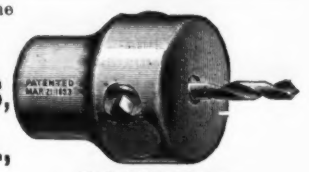
Windsor Locks, Conn., U. S. A.



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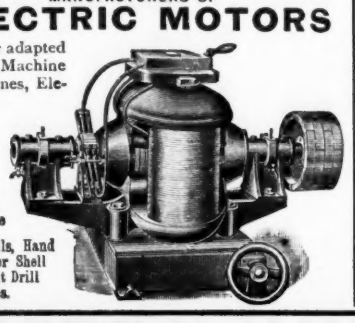

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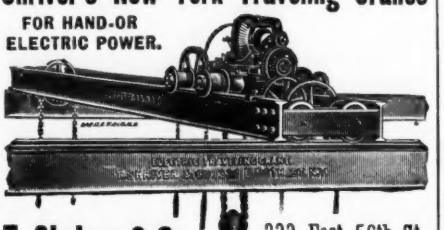
FOR HAND-OR ELECTRIC POWER.



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For Lathes, Drills, Chucking and Screw Machines, and for Special work. . . . . .
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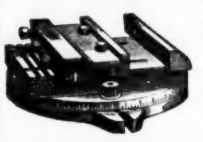

Jordan Planer Chucks.
For Price and Description, address
C. W. JORDAN
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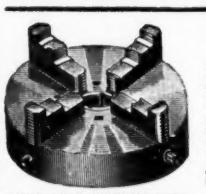
WORCESTER, MASS.

PEQUOT DRILL CHUCK.
A new Drill Chuck having a more powerful grip than any chuck ever offered. This seems a broad claim, but we prove it to mechanics who will examine. Ask at your dealers or write us for particulars.
THE D. E. WHITON MACHINE CO.,
5 Oak Street, New London, Conn., U. S. A.,
OR, SELIC, SONNENTHAL & CO.,
85 Queen Victoria St., London, E. C., England.

CHUCKS
The "National."
INDEPENDENT, UNIVERSAL, or COMBINATION.

Est'd 1882. Strongest. Easiest to change. Best finish. Reversible Jaws (patented) giving 5 changes including every possible position. ILLUSTRATED CATALOGUE sent. Liberal discounts. Prompt shipment. W. WHITLOCK, 39 Cortlandt St., N. Y.—Works, Hoboken, N. J.



SKINNER CHUCKS.
Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.
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WE LEAD, OTHERS FOLLOW.

Sweetland Combination Chuck.
Reversible Jaws. Accurate, Standard Independent, Solid Shell, Solid Reversible Jaws, Strong and True.
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Write The Pratt Chuck Co., Clayville, N. Y., U. S. A., for free illustrated catalogue of
POSITIVE DRIVING DRILL CHUCKS.
Will drive either straight or Taper Shank Drills, Reamers, Rose Bits, etc., of any size, without a possibility of their slipping.
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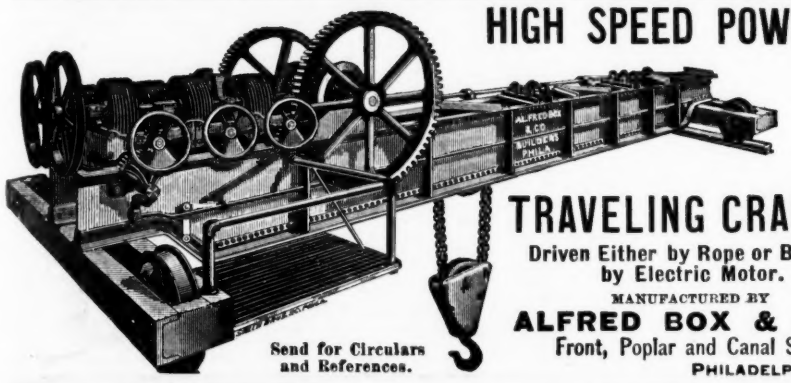
HIGH SPEED POWER TRAVELING CRANES.



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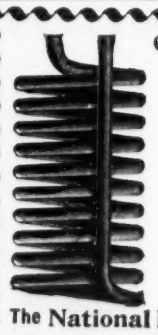

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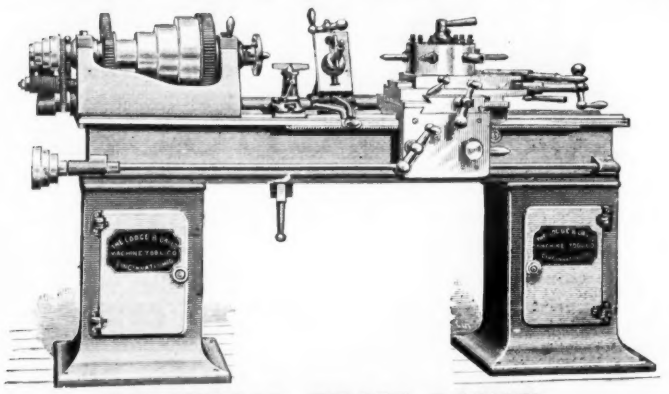

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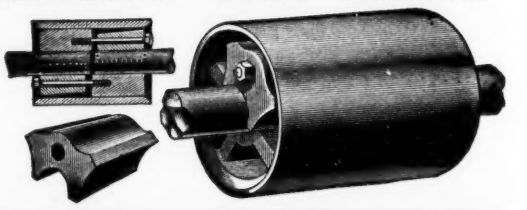

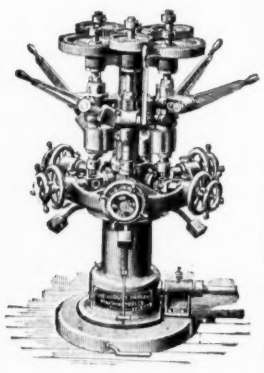

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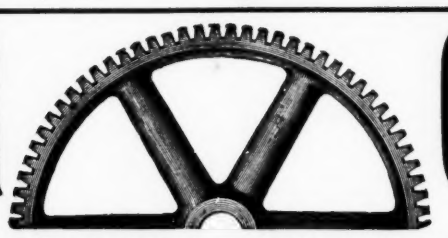

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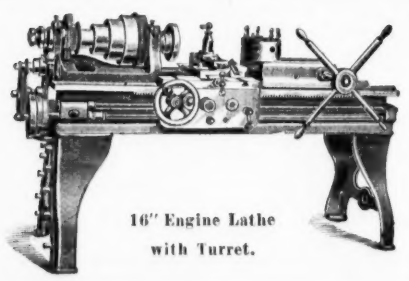

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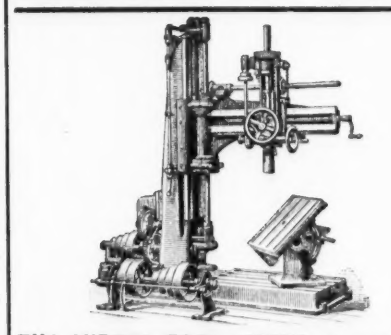

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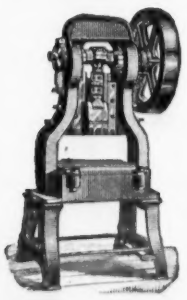

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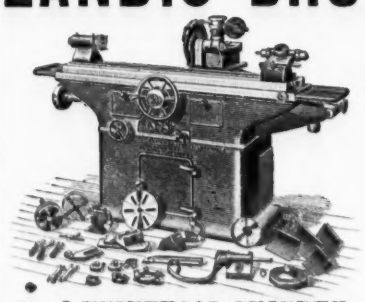

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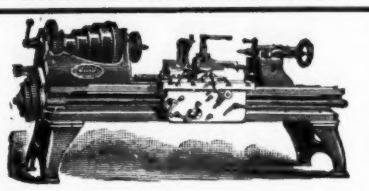

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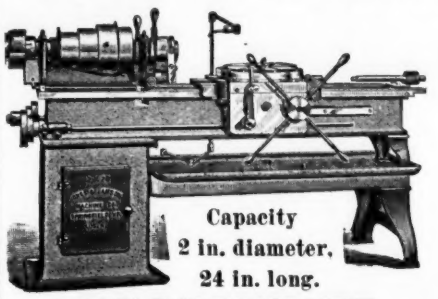

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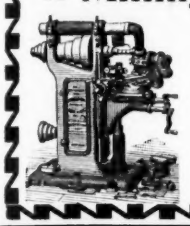

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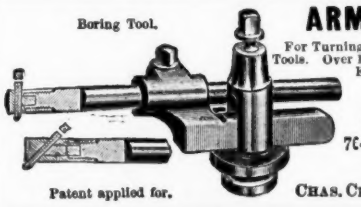

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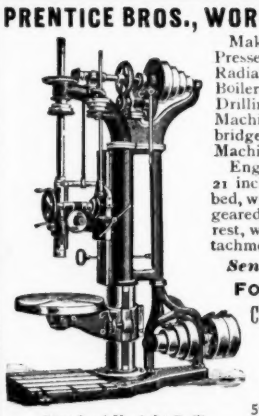

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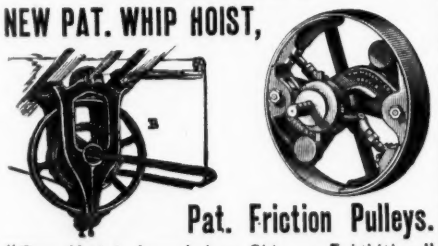

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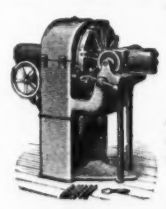

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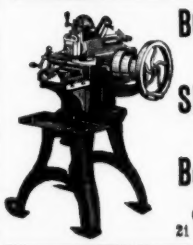

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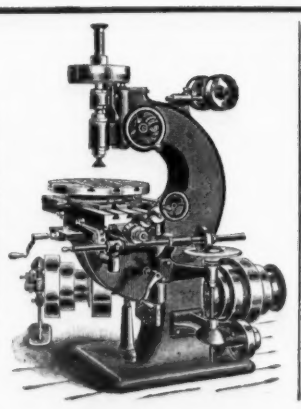

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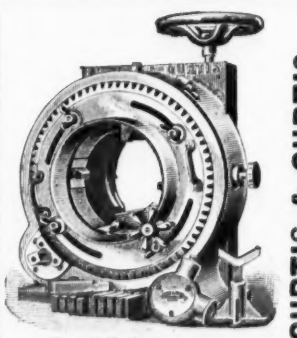

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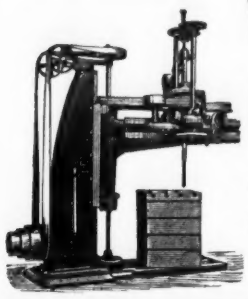

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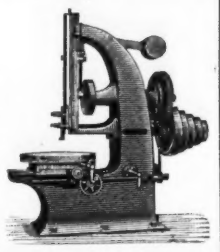

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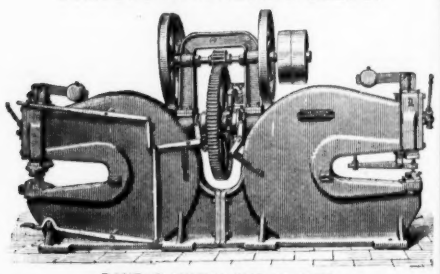

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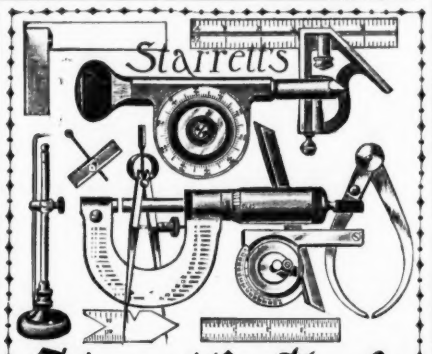

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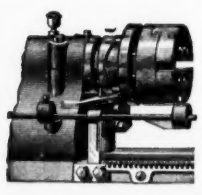

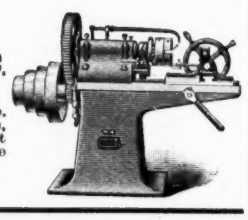

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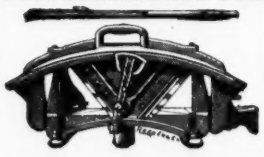

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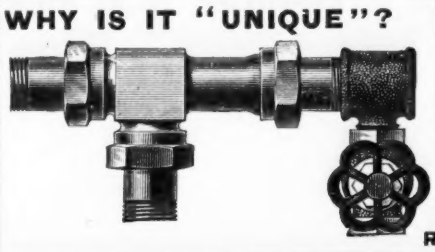

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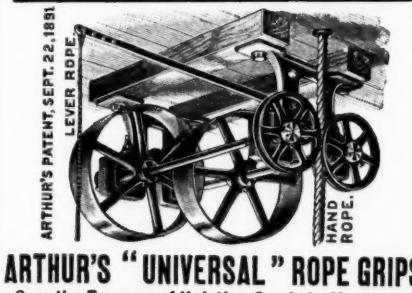

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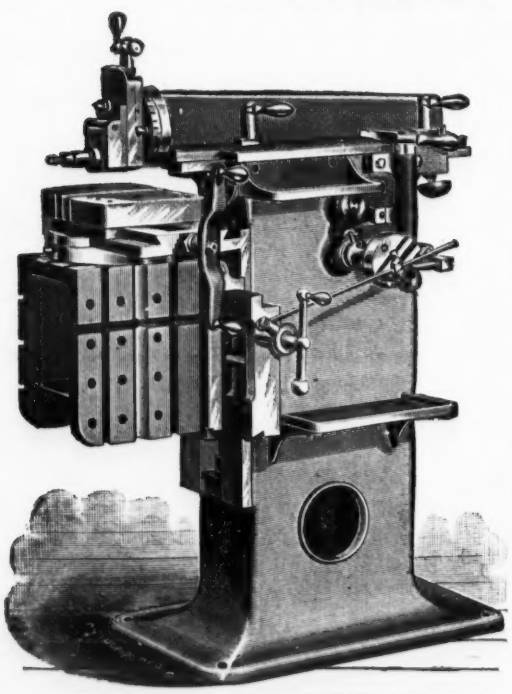

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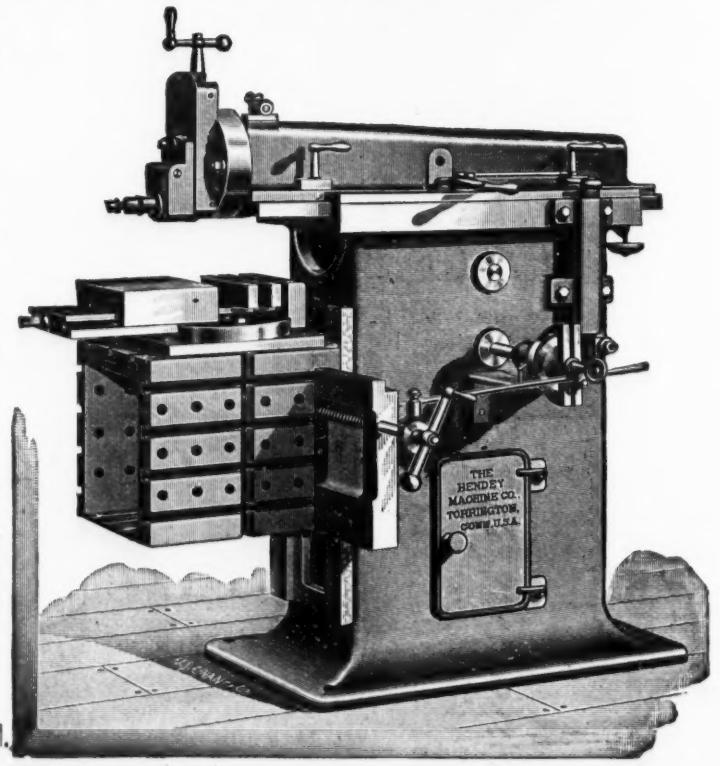

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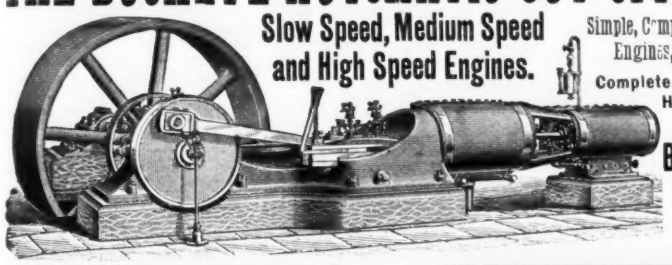

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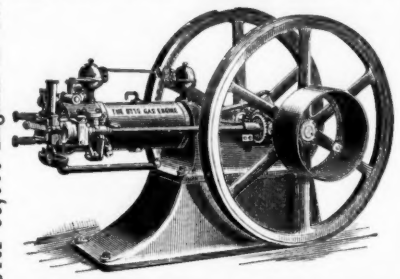

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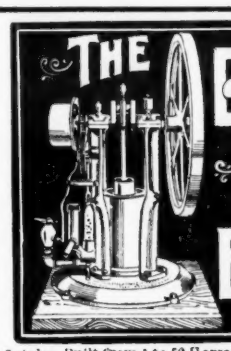

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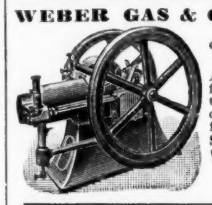

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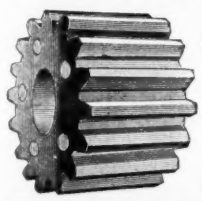

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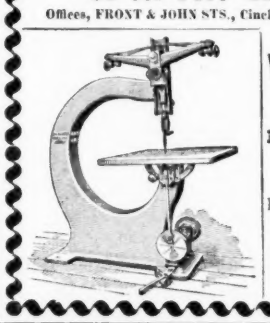

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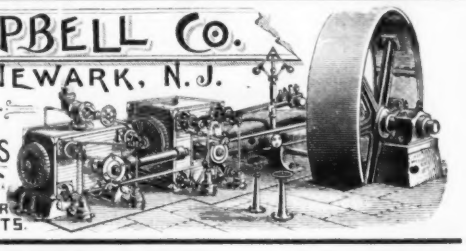

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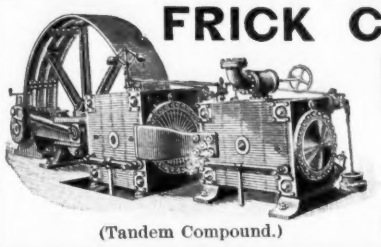

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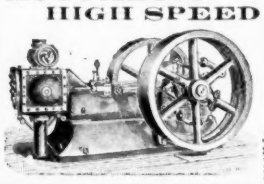

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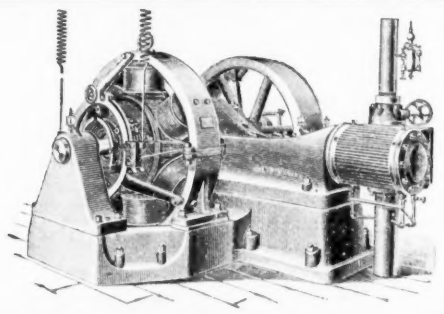

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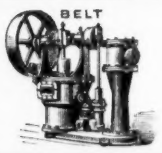

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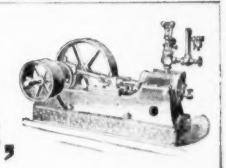

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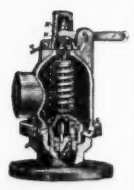

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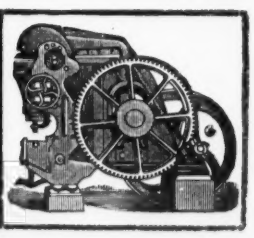

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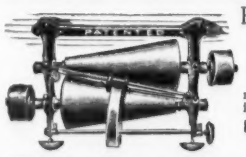

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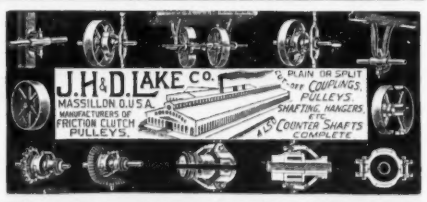

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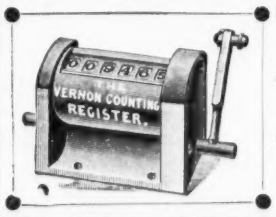

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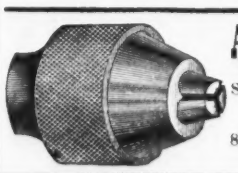

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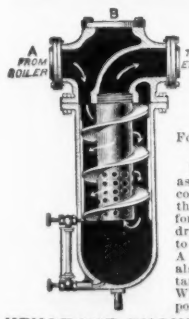

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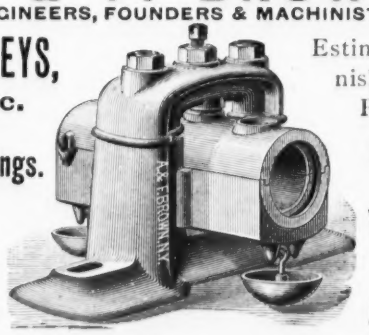

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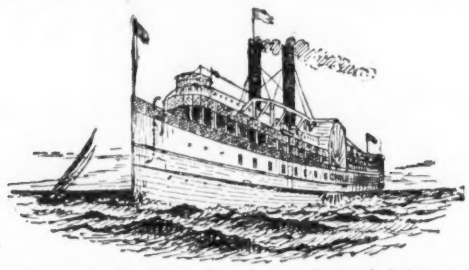

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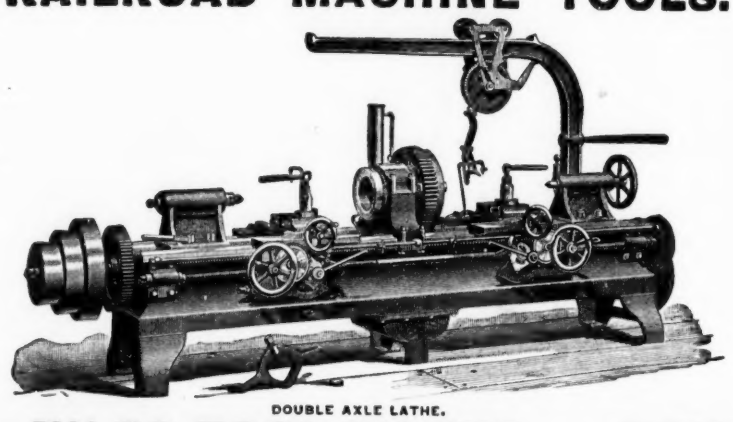

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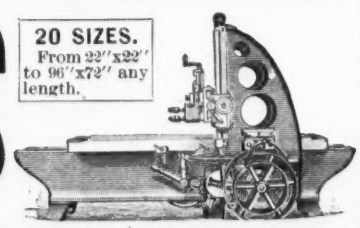

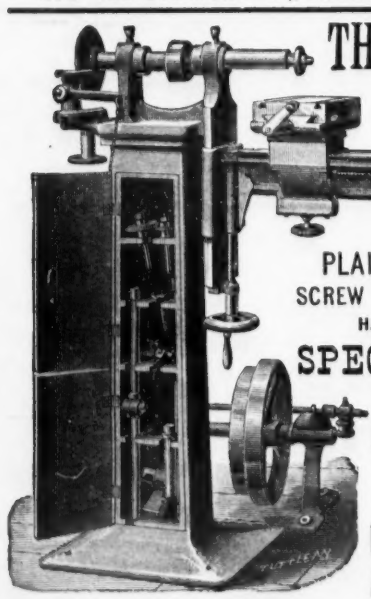

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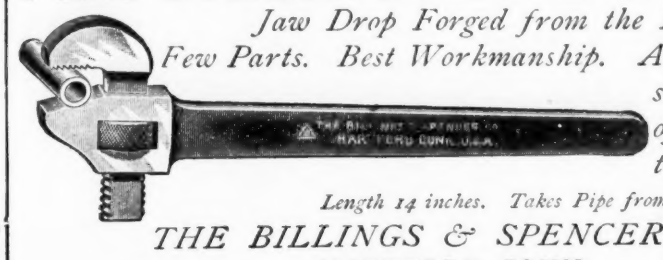

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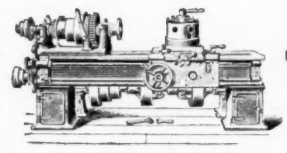

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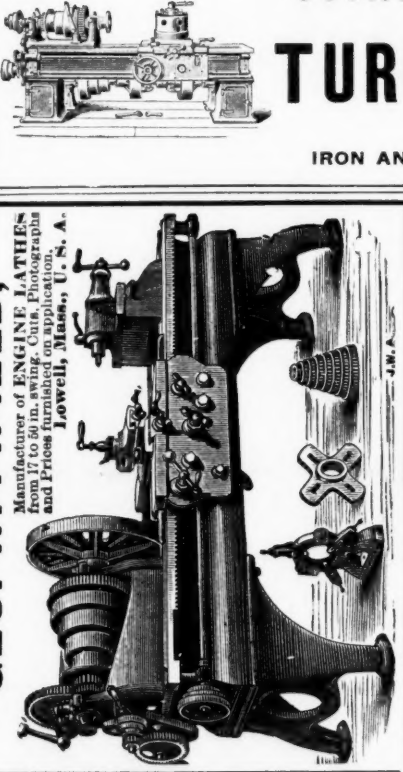

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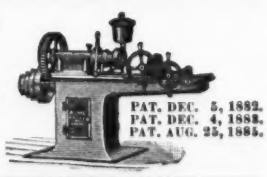

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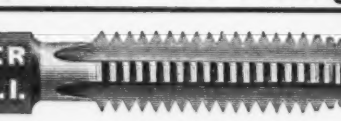

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